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PREFACE

Agricultural Finance Review provides a forum for presentation of research and discussion of issues in agricultural finance. Publication is annual, and all articles are contributed by scholars in the field. Articles on assigned topics may be commissioned occasionally.

Volume 43 was the first to be published at Cornell University. The previous forty-two volumes were published by the United States Department of Agriculture. AFR was begun in 1938 by Norman J. Wall and Fred L. Garlock, whose professional careers shaped much of agricultural finance research for many years. Since that time, professional interest in agricultural finance has continued to grow, involving larger numbers of people and a greater diversity in research topics, methods of analysis, and degree of sophistication. We are pleased to be a part of that continuing effort and development, and we invite your suggestions for making improvements in *Agricultural Finance Review*.

The effectiveness of this publication as a means of promoting agricultural finance research and discussion depends on its support by the profession. We have been pleased by the response in these first three years both in terms of manuscripts received and willingness of individuals in the profession to review submitted manuscripts. Eighteen manuscripts were received for volume 46. The seven contained herein were selected for publication. We thank all those who submitted manuscripts for our consideration.

We express our sincere thanks to the following individuals who contributed their valuable time to review submissions for us:

Tim Baker
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Manuscripts for the 1987 issue should be received by February 1, 1987. Manuscripts will be accepted at any time, however, and those received after February 1, will be considered for the 1988 issue.

John R. Brake, editor
Eddy L. LaDue, associate editor
Loren Tauer, associate editor

Crop Insurance and Credit: A Farm Level Simulation Analysis

Burton W. Pfleuger and Peter J. Barry

Abstract

A combination of survey and simulation procedures measured how a sample of nonreal estate lenders in Illinois responded to a farmer's use of crop insurance and evaluated the effects of the responses on farm financial performance. Survey results indicated a positive credit response by about 60 percent of the lenders, and little change in interest rates and loan maturities. The simulation results for a highly leveraged farm indicated that crop insurance and the credit response improve farm survival and liquidity, although additional borrowing occurs at relatively high interest costs.

Key words: credit, crop insurance, risk management, simulation.

The financial adversities experienced by the farm sector in the 1980s have continued to highlight the close interrelationships between farm borrowers and their lenders. Both parties have a significant stake in actions that influence the profitability, liquidity, and risk positions of farm businesses. Especially important is the formation of effective managerial strategies—including the use of public programs—for responding to various sources of risk in agriculture and thus strengthening the lender-borrower relationship.

This study analyzes the relationships between farmers' use of crop insurance and the cost and availability of credit from their major nonreal estate lenders. As a risk response crop insurance responds directly to shortfalls in crop yields. Use of insurance is believed to reduce lending risks and to contribute to the economic performance of both the borrower and the lender. Crop insurance also has important policy implications because it is one of several policy instruments used by the federal government to implement programs of stabilization, liquidity, and income enhancement for farmers. Indeed, the Federal Crop Insurance Act of 1980 authorized an expansion of the insurance program to become the primary form of disaster protection for farmers. The ranges of crops, regions, and financial protection were broadened substantially, and much emphasis was placed on acquainting farm lenders with the provisions and the benefits of the expanded program in order for them to encourage insurance use by their farm borrowers.

Little empirical evidence is available, however, about the lenders' responses to farmers' use of crop insurance or the

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implications of those responses for the financial performance of farm businesses. If, for example, farmers' use of crop insurance results in greater credit availability and/or lower financing costs, then farmers' insurance decisions and their resulting risk positions could be significantly affected. Prior studies (Gardner and Kramer; King and Oamek; Kramer and Pope; Lee and Djogo) focusing on the farm level effects of crop insurance have essentially assumed independence between use of insurance and the farm's financial organization. That assumption leaves unanswered several important questions about the financial effects of insurance: Do lenders in fact respond to farmers' use of crop insurance? Is their response a price response, a nonprice response, or both? Are the responses significant? Do the responses differ among farms with different yield risks and structural characteristics? Can the responses be measured, analyzed, and integrated into a broader analysis of farm performance?

This study addresses some, but not all, of those questions. A combination of survey and simulation procedures measured how a sample of nonreal estate lenders responded to a farmer's use of crop insurance and evaluated the effects of those responses on farm financial performance over a multiyear horizon. The empirical focus was on the use of crop insurance by representative farms in two regions of Illinois that differed substantially in relative yield variability. The interregional focus provided some generality about the differences in lender response to the relative amount of yield risk and to the use of crop insurance in the two regions. In the following sections, a description of the study design is presented, the procedures for generating the lender responses are discussed, the survey results are identified, and their implications for financial performance are evaluated using a farm level simulation model.

Design of the Study

The study focused on cash grain farms in Illinois and on the responses to crop insurance by the farms' major nonreal estate lenders, such as commercial banks and Production Credit Associations (PCAs). The basic components of the study included the identification of two regions in Illinois that differ substantially in their yield variability, the specification of representative farms in each region to serve as a basis for the survey and the simulation procedures, the survey process and the analysis of the results, and an evaluation of the effects of the lenders' responses on the financial performance of the representative farms using the farm level simulation model. Each of those components is summarized briefly in this section (see Pflueger for a more detailed description).

The identification of the two regions that differ in yield variability began with the collection and the analysis of data on corn yields from the Statistical Reporting Service (SRS) in Illinois. Corn yield data were collected for all counties of the state for the period, 1972 to 1982. After testing the data, no trend was found, and then means, variances, and coefficients of variation were determined. Using the coefficients of variation, two three-county regions that differ substantially in their relative yield variability were selected. The low variability region, located in east central Illinois, had an average coefficient of variation for corn yields of .151. The high variability region, located in southern Illinois, had an average coefficient of variation of .257.[1]

The selection of lenders to be surveyed coincided with the delineation of the two variability regions. A broader set of counties was allowed in order to increase the sample size and to allow credit markets for both lenders and borrowers to range beyond county boundaries (the low and high variability regions contained twelve and fifteen counties respectively). All PCAs in those counties were included in the sample, as well as all commercial banks that on December 31, 1983, had at least $2 million in agricultural loans or a ratio of agricultural loans to total loans that exceeded .50. The

[1]Because the SRS data were disaggregated from the state level to the county level, the relative yield variability was checked by examining historic yield data on individual farms in the two regions that had participated in the Illinois Farm Business Farm Management System (FBFM) during the 1972–82 period. The means, variances, and coefficients of variation again were measured; they largely coincided with the measures from the SRS data. That validated the selection procedure based on the SRS data. Later, in the simulation analysis, the parameters of the yield distributions for corn and soybeans were estimated using individual farm data from the FBFM system.

sample of lenders for the low variability region contained sixty-six banks and eleven offices of four PCAs. The lender sample for the high variability region contained fifty-nine banks and eleven offices of three PCAs. Thus the sample size totaled 147 lenders.

To obtain the lenders' response to the use of crop insurance, three survey methods were considered: (a) collecting data from existing loan portfolios; (b) surveying lender attitudes by questionnaire; or (c) surveying lender responses to a simulated borrowing situation. The simulated borrowing approach has an advantage over the other methods because it directly generates quantitative measures of the lenders' price and nonprice responses to the farm practices or to the characteristics being studied. Moreover, that method has been used successfully in several previous studies (Barry, et al.; Barry and Willmann; Baker). Therefore, the third method was the preferred choice. A mail questionnaire instead of personal interviews was selected to implement the survey.

Once the lender responses to crop insurance were summarized and analyzed, they were integrated into a farm level simulation model to evaluate their effects on the model farm's profitability, liquidity, solvency, and survivability over a ten-year planning horizon. The simulation model, called PICFARM, is maintained and utilized by the U.S. Department of Agriculture (USDA) for analyzing the farm level effects of various policy options and economic scenarios (Baum and Richardson; Baum). The USDA version is adapted from the model, developed by Richardson and Nixon, that has received wide use and has been documented in the literature (e.g., Richardson and Nixon; Richardson and Condra; Perry, et al.). The model is well suited for use in the study. It contains a comprehensive set of financial components that accommodated the results of the lender survey; its stochastic properties allowed random variation in crop yields; and it included various specifications on major policy instruments available to farmers such as Federal Crop Insurance.

The specification of the representative farms in the two variabiity regions was used both to elicit the lender response and to simulate business performance over time. The differing characteristics of the survey environment and the simulation model precluded an exact matching of the model farm's specifications for those two purposes. Nonetheless, a high degree of consistency was maintained. The greater weight in the specification process was placed on designing the survey to ensure the highest possible quality of lender response. In the following sections the farm specifications for both the survey and the simulation process are described in greater detail.

Lender Responses to Crop Insurance

The lender survey contained two case loan requests—one included the use of crop insurance by the farm borrower and one did not. The lenders also received a biographical sketch of the borrower, a description of the Federal Crop Insurance program as it applied to the case farm, and the case farm's historic and projected financial statements. Those materials were prepared under the guidance of an advisory panel of farm lenders who served as a pretest mechanism for the survey. Using that information, the lenders were asked to evaluate and to respond to the case loans in terms of maximum credit limits for operating and capital loans, interest rates, loan maturities, security requirements, and other loan provisions.

Farm Characteristics

The representative farm's beginning financial position was structured to represent a relatively young, low equity borrower who owned a small portion (10 percent) of the land he operated and leased the rest on a cash rent basis. The initial ratio of debt to equity was set at approximately 2.70 in the low variability region (equivalent to a debt-to-asset ratio of .73) and 2.34 in the high variability region (a debt-to-asset ratio of .70). Those specifications reflect the high financial risk of the 1980s and depict a farm that has used much of its credit reserves in borrowing (USDA). Despite the high leverage, the case farmer was characterized to the lender as having gained the necessary experience and improved his financial position to the point where he could begin to upgrade some of his machinery, equipment, household facilities, and other capital assets to provide for orderly future growth. Within that context, the loan request was set high

enough to fully test the farm's credit limits, especially on capital credit. Moreover, individual capital items and the operating loan could be reduced or deleted until the lender's approval occurred. The loan requests with and without the use of crop insurance were the same except for a lower operating loan in the high variability region to reflect the smaller size of farm. In addition when insurance was used, the operating loans were higher due to the financing needed to cover the insurance premium. The case farm for the low variability region had a larger total size (1,000 acres versus 600 acres), higher yield expectations (128 bushels per acre versus 87 bushels per acre for corn, and 41 bushels per acre versus 33 bushels per acre for soybeans), higher land values ($2,500 per acre versus $2,000 per acre), and other minor adjustments due to differences in operating characteristics and economic conditions between the two regions.

The case farm situations also were designed so that crop insurance was the farmer's principle risk response. Crop enterprises were limited to corn and soybeans (typical for each region) for rotation purposes; crop sales occurred at harvest with no use of hedging or forward contracting; no participation in other government programs occurred; little financial reserves were maintained; little or no credit reserves were held, at least after the loan request was granted; and leasing of farm land occurred with cash rent rather than share rent so that all the yield risk was carried by the farm operator. Finally, when crop insurance was used, the case farmer selected the highest levels available for yield coverage and valuing losses to ensure that the lenders' responses would reflect the full utilization of crop insurance.

Survey Responses

The survey was mailed in late 1984 with the final lender response occurring in early February 1985. In total sixty-nine responses were received—forty-three from the low variability region and twenty-six from the high variability region—for a gross response rate of 46.9 percent. Of the total responses, fifty-five were considered useful for a net response rate of 37.4 percent. Of the useful responses, thirty-four were from the low variability region and twenty-one from the high variability region. A blank survey, an incomplete survey, and a loan request exceeding the institutions' legal lending limit were responses that were not useful. Timing likely had a major influence on the response rate. By necessity, the survey was sent during a busy time of the year for the agricultural lenders and at a time of significant financial stress in agriculture. Thus, most lenders were busier than usual with customer counseling, credit analysis, and loan workouts.

Empirical Results

Table 1 gives a descriptive summary of the lender responses on the major variables contained in the survey, classified by region and by use of insurance: no insurance (Case A) and insurance (Case B). The variables include the dollar and the percentage amounts of credit, and the interest rates on operating and capital credit and their respective loan maturities. The credit responses are described below. For now it is interesting to note that the mean interest rates on operating and capital credit showed essentially no response to the use of crop insurance and were nearly the same for the two regions. The average loan maturities showed moderately higher responses to the use of insurance, especially in the high variability region. The total loan request was granted by only one lender, although crop insurance was needed to generate that response. Most of the lenders' responses occurred in the curtailment of capital credit. In contrast, thirty-seven (67.3 percent) of the lenders granted the full operating loan request under Case A conditions and forty-two (76.4 percent) granted the full operating request under Case B conditions.

The lenders who exhibited credit and interest rate responses are indicated in Table 2. The credit responses are based on comparisons of the percentages of the loan granted under Cases A and B. A positive (negative) response occurred if the percentages of operating credit, capital credit, or both (total credit) increased (decreased) from Case A to Case B. Price responses occurred when the interest rates were lower and/or the loan maturities were longer for Case B. As Table 2 shows, twenty-three of the fifty-five lenders showed no credit response to crop insurance. Twelve showed an operating credit response, thirteen showed a capital credit response, four showed both an operating and a capital credit response, three

Table 1. Summary Measures of Lender Response to Crop Insurance by Variability Region

	Low Variability Region				High Variability Region			
	Mean Response	Standard Deviation	Minimum Response	Maximum Response	Mean Response	Standard Deviation	Minimum Response	Maximum Response
Case A, No insurance								
Operating credit								
$ extended	194,060	73,412	0.0	227,000	74,190	31,988	0.0	95,000
% extended	85.49	32.34	0.0	100.00	78.09	33.67	0.0	100.00
Capital credit								
$ extended	34,532	42,124	0.0	148,600	35,898	40,900	0.0	106,400
% extended	22.00	26.83	0.0	94.65	22.86	26.06	0.0	67.71
Total credit								
$ extended	228,592	96,490	0.0	375,600	110,088	44,775	0.0	189,500
% extended	59.59	25.16	0.0	97.81	43.71	17.78	0.0	75.20
Interest rates								
Operating credit, %	13.75	.66	12.5	15.3	13.59	.45	12.50	14.50
Capital credit, %	13.78	.62	13.0	15.3	13.60	.73	12.50	15.00
Loan maturity								
Operating credit, yrs.	.92	.19	.50	1.00	.79	.24	.50	1.00
Capital credit, yrs.	4.50	1.50	1.00	7.00	4.37	2.52	1.00	7.00
Case B, Insurance								
Operating credit								
$ extended	229,310	9,529	198,500	233,000	91,238	20,224	23,000	101,000
% extended	98.42	4.09	85.19	100.00	90.33	20.02	22.77	100.00
Capital credit								
$ extended	44,441	47,142	0.0	157,000	54,798	47,455	0.0	148,600
% extended	28.31	30.03	0.0	100.00	34.90	30.23	0.0	94.65
Total credit								
$ extended	273,751	47,787	211,050	390,000	146,040	45,224	89,000	249,600
% extended	70.19	12.25	54.11	100.00	56.61	17.52	34.50	96.74
Interest rates								
Operating credit, %	13.60	.64	12.50	15.30	13.58	.44	12.50	14.50
Capital credit, %	13.76	.62	13.00	15.30	13.64	.70	12.50	15.00
Loan maturity								
Operating credit, yrs.	.92	.18	.50	1.00	.77	.24	.50	1.00
Capital credit, yrs.	4.77	1.81	1.00	10.00	5.10	2.47	1.00	10.00

showed an interest rate response, and four showed a negative credit response.

When crop insurance was used 58.2 percent of the lenders granted either more credit or a lower interest rate, with the capital credit response predominant. Of that group of lenders, 21.8 percent had a positive response for operating credit, 23.6 percent for capital credit, 7.3 percent for both operating and capital credit, and 5.4 percent showed a price response. Moreover, the incidence of response was greater in the high variability region where 85.7 percent of the lenders indicated a credit response compared to 41.2 percent in the low variability region. Still, 14.3 percent of the lenders in the high variability region indicated a reduction in credit that apparently was due to the presence of the insurance premiums ($6 per acre of corn and $4 per acre for soybeans) in the operating loan for Case B. Thus, the lenders' responses exhibited considerable disparity.

Table 3 presents mean values and standard deviations of the lender responses for the various types of credit and the use of *t* tests to analyze the statistical significance of the response to crop insurance within the regions and by type of lender.[2] The first

[2]The use of *t* tests occurred because the analysis focused on the differences in the credit responses when crop insurance was or was not included in the case loan requests. No attempt was made to explain how lender characteristics or other factors might affect the lenders' responses. Other statistical procedures were also considered but not used. Analysis of variance was not appropriate since the bounds on the credit requests yielded limited dependent variables. Tobit analysis could handle the bounded feature, but it was not strictly appropriate because more than one bound was in effect simultaneously for some lenders.

Table 2. Number of Lenders Responding in Price and Nonprice Terms to Crop Insurance[a]

	No Response		Operating Credit Only		Capital Credit Only		Operating and Capital		Price Response		Credit Decrease	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All lenders	23	41.8	12	21.8	13	23.6	4	7.3	3	5.4	4	7.3
Low variability region	20	58.8	6	17.6	5	14.7	3	8.8	3	8.8	1	2.9
High variability region	3	14.3	6	28.6	8	38.1	1	4.8	0	0.0	3	14.9
Banks	18	39.1	10	21.7	12	26.1	4	8.7	2	4.3	3	6.5
PCAs	5	55.6	2	22.2	1	1.1	0	0.0	1	1.1	1	1.1

[a]Table shows the percent of responses for the category in each row. They may total more than 100 percent because lenders may give more than one response.

Table 3. Percentages of Loan Requests Granted by Type of Credit, Regions, and Type of Lender

	Case A (No Insurance)		Case B (Insurance)		Case B Minus Case A
	Mean Response	Standard Deviation	Mean Response	Standard Deviation	Mean Difference (*t* ratio)
All lenders					
Operating credit	82.67	32.7	95.33	13.2	12.66 (3.16)*
Capital credit	23.33	26.3	29.01	28.7	5.68 (2.30)*
Total credit	53.48	23.7	65.00	15.8	11.52 (4.40)*
Low variability region					
Operating credit	85.49	32.3	98.42	4.1	12.93 (2.31)*
Capital credit	22.00	26.8	25.37	27.6	3.37 (1.02)*
Total credit	59.53	25.1	70.19	12.3	10.66 (2.88)*
High variability region					
Operating credit	78.10	33.7	90.33	20.0	12.24 (2.22)*
Capital credit	22.86	26.1	34.90	30.2	12.04 (2.27)*
Total credit	43.69	17.8	56.60	17.5	12.92 (3.59)*
Banks					
Operating credit	79.53	35.0	94.67	14.3	15.14 (3.22)*
Capital credit	24.91	27.2	33.46	29.3	8.54 (2.59)*
Total credit	52.50	25.6	66.49	16.5	13.99 (4.66)*
PCAs					
Operating credit	98.68	4.0	98.72	2.5	0.04 (0.04)
Capital credit	9.10	16.5	6.27	7.0	-2.83 (0.68)
Total credit	58.48	9.1	57.39	9.2	-1.09 (0.39)

*Statistically significant at the five percent level

section of the table shows the responses by all lenders without regard to region. As shown by separate rows of that section, 82.67 percent of all lenders granted operating credit in Case A and 95.33 percent granted it in Case B. Capital credit was granted by 23.33 percent of lenders in Case A and 29.01 percent of lenders in Case B. Total credit was granted by 53.48 percent of lenders in Case A and 65 percent of lenders in Case B. For each type of credit the increase for Case B compared with Case A was statistically significant at the 5 percent level; the mean differences and *t* ratios are shown in the last column of the table. Thus, for the aggregate responses, the results indicate that lenders on average would extend greater amounts of operating, capital, and total credit to those borrowers who use insurance according to the insurance provisions specified in the loan request.

The next two sections of Table 3 consider the magnitude and significance of the credit response to crop insurance within the two regions. For the low variability region the mean values of the differences in credit responses for Cases A and B are positive for each type of credit, although statistical significance occurs only for operating credit and total credit. For capital credit, the mean value of the percent of loan granted increased from 22 percent in Case A to 25.37 percent in Case B—a relatively small increase of 3.37 percentage points compared with that for operating credit. For the high variability region, the mean values of the differences in credit responses are positive as well as statistically significant for each type of credit. Capital credit in particular has a much stronger increase in response to crop insurance, with the difference between Case A and Case B averaging 12.04 percentage points. Based on those results, differences in variability characteristics between regions may well affect the lenders' nonprice responses to crop insurance, especially for capital credit.[3]

The final two sections of Table 3 consider the responses to crop insurance by type of lender. For commercial banks, the mean values of the differences in credit responses between Cases A and B are positive and statistically significant for each type of credit. Those results roughly parallel the responses for all lenders, in part because commercial banks are dominant among the responding lenders. The results for PCAs are subject to greater qualification because the number of their responses (nine) is relatively low. Nonetheless, some interesting differences occur in the responses of the two types of lenders. None of the mean values of the differences in credit responses for PCAs were statistically significant. In general the PCAs granted the full operating loan request regardless of the crop insurance strategy but granted little, if any, of the capital loan request. In fact, the mean values of the capital and total credit responses for PCAs declined due to the negative capital credit response to crop insurance by one of the PCA respondents in the high variability region. Without farmers' use of crop insurance banks appeared more conservative grantors of operating credit compared with PCAs, although the banks' capital credit responses were stronger. The operating credit responses evened out when crop insurance was used, although banks continued to have a stronger capital credit response.

Simulation Specifications

The farm level effects of the lender responses were analyzed with the simulation model using three primary scenarios. Other secondary scenarios evaluated the sensitivity of the results through changes in key parameter values. The three primary scenarios were: farm performance without

[3]Interregional comparisons of the credit responses are hampered by the differences in sizes and other operating characteristics of the representative farms. The sizes of the operating loan requests in the survey were scaled according to farm size; thus, the mean responses on the percent of operating loan granted are comparable. Moreover, the differences in the mean responses for operating credit (85.49 percent and 78.10 percent for Case A) are not significant at the 5 percent level, but do become significant at the 10 percent level. In contrast, the sizes of the capital loan requests in the survey were the same for the two regions, even though the farms differed in size and debt levels. To achieve interregional comparability, the initial equity-to-asset ratios for the two farms were estimated under Case A conditions, including the capital loan requests granted by the lenders in each region. The equity-to-asset ratios did not differ significantly between the two regions for the Case A conditions, suggesting that the capital credit responses without insurance were essentially the same in the two regions. As occurred above, the changes in the equity-to-asset ratios when insurance was used (Case B) were significant within each region at the 5 percent level.

the use of crop insurance, farm performance with crop insurance but without the lender response, and farm performance with both crop insurance and the lender response. For each scenario in the two variability regions, the model ran a hundred stochastic interactions allowing yields for corn and soybeans to be selected at random from normal probability distributions measured over the 1972–82 time period using farm level yield data from the Illinois FBFM system.[4] To maintain the focus on crop insurance as the major risk response, only yield variability was considered.

The model farms were specified to stay the same size and in a fixed asset structure over the model horizon. Providing for growth opportunities would have added realism and would have allowed the model farm to use the additional credit attributed to crop insurance in financing asset acquisition and perhaps added to profit potential. However, the farm's initial position of low equity, high leverage, and vulnerability to financial stress suggested a conservative approach to future expansion plans and an emphasis on the liquidity-providing, stabilizing features of crop insurance. Moreover, allowing expansion would require a pace of growth and related borrowing needs that would be consistent with the risk attitudes of the model farmer, including his or her valuation of crop insurance as a response to risk relative to other risk responses and sources of risk. The nature of the simulation model precluded using that type of attitudinal information, so the more conservative approach based on a steady size state was used.

The financial components of the simulation model allowed the lender responses to crop insurance to be specified in terms of interest rates, loan maturities, and minimum equity-to-asset ratios for intermediate and total assets. Since the survey responses showed no substantial changes in interest rates or loan maturities in response to crop insurance, major emphasis was placed on the nonprice effects. The model placed no restrictions on the amount of short-term credit during a year. That specification was consistent with the survey results which showed little curtailment of operating credit. Any cash flow deficits at year end were covered by intermediate-term borrowing in the following year until the intermediate limit was reached. Refinancing through long-term loans occurred until the overall solvency limit was reached, then the farm was declared insolvent. Since the survey results indicated generally positive responses to all types of credit in both variability regions, the approach to including the lender responses was to reduce the minimum equity-to-asset ratios for the total farm and for its intermediate assets by .05 and .10, respectively, when the third scenario was used. At the farm level, that reduced the solvency limit from .40 to .35.[5]

Other model specifications included data on commodity prices, yields, costs of production, depreciation patterns, inventory values, beginning indebtedness, interest rates, inflation rates, consumption, and taxation. Costs of production, inventories for machinery, and other farm assets were estimated from FBFM records and from the advisory panel of lenders. Data for interest and inflation rates were obtained from the USDA's specification of the PICFARM model. The USDA provided data for a representative farm constructed from SRS data using consistent interest and inflation rate expectations obtained from the *Economic Indicators of the Farm Sector* and the *Agricultural Finance Data Book*. Most

[4]Yield variability was originally specified with a beta distribution to reflect the tendency for yields to be negatively skewed. In the final analysis, normally distributed crop yields were used to overcome an apparent malfunction of the beta component of the simulation model that caused the mean values of the simulated crop yields to differ substantially from the true means and the simulated variances of the crop yields to trend upward over time rather than remain stationary. Using normality corrected both of the problems and tended to reduce by small amounts the likelihood of exceedingly low crop yields. Thus the payoffs from using crop insurance by an unknown but likely small amount were understated.

[5]The minimum equity-to-asset ratio of .40 implies that the farm started in an insolvent position because a ratio of .30 was used in the lender survey. Several factors are involved here. Given the adverse agricultural conditions of the mid-1980s and the financial position of the case farms, it is likely that lenders would set a lower level of leverage as the target over time or as the default rate for insolvency purposes. To use the stochastic subroutine of that version of the PICFARM model, the first year of the horizon had to be run deterministically for the stochastic process to begin. That ensured a known and a moderately successful level of farm performance in year one. Finally, the case farms were formulated to reflect an improving trend of historic performance. Thus, the solvency criterion was set at .40 compared with the initial value of .30.

inflation rates were in the 6 percent to 8 percent range over the ten-year horizon, and interest rates were in the 8 percent to 10 percent range. The tax and consumption specifications also were those found in the PICFARM model, as were the price projections on corn and soybeans.[6]

Yield data were estimated from farm level FBFM records over the 1972–82 period for the three-county regions cited earlier. The low variability region had per acre expected yields and standard deviations for corn of 127.8 bushels and 20.5 bushels, respectively, and for soybeans, 41.2 bushels and 5.1 bushels, respectively. The high variability region had expected yields and standard deviations of 81.2 bushels and 21.7 bushels for corn and 32.9 bushels and 5.7 bushels for soybeans. Information on crop insurance premiums was obtained from the regional field office of the FCIC. The same premiums could be used for each variability region because the FCIC actuarial tables did not indicate substantial differences in the rates. The initial insurance premiums and price protection levels were $6 per acre and $2.90 per bushel, respectively, for corn and $4 per acre and $6 per bushel for soybeans. Both the premiums and the price protection levels were adjusted over the model horizon to maintain a constant relationship to the USDA's price patterns for corn and soybeans.

Simulation Results

The simulation results were evaluated using a set of performance criteria that represented the farm's profitability, liquidity, and risk positions. Consistent with the type of output produced by the PICFARM model, profitability was measured by the net present value of the income flows over the model horizon, by the present value of ending net worth, and by the Van Horne profit index (beginning net worth plus the net present value of the income flow divided by beginning net worth). When the model was run stochastically, the output was not in a form suitable to calculate annual rates of return to assets or to equity. Liquidity was measured by the level of ending cash reserves reported in the model output. Again, no annual liquidity ratios could be calculated; however, the farm's steady size state caused profits from operations to accumulate as cash reserves for liquidity purposes. Finally, the farm's solvency position was measured by the mean value of the equity-to-asset ratio at the end of the model horizon and by the model farm's probability of survival over the horizon. The probability of survival is determined by the number of iterations in which the farm operation remained solvent.

The use of crop insurance together with the lender response was expected to reduce and to stabilize the farm's profitability position as indicated by the mean values and coefficients of variation over the solvent iterations for the various profitability measures. In addition, insurance was expected to improve the farm's liquidity, solvency, and survival prospects. Those results indeed tended to occur, although the farm's profitability levels also improved in the crop insurance scenarios relative to the no insurance case. As Table 4 shows, the use of crop insurance in scenario 2 (without the lender responses) increased and stabilized the profitability and liquidity measures for both variability regions. The ending equity-to-asset ratio increased marginally, and the probabilities of survival increased considerably from .580 to .710 in the low variability region and from .450 to .620 in the high variability region. The improvement in profitability likely reflects the combined effects of the level of subsidy in the insurance premiums, which transfers insurance benefits to farmers, and the tendency for indemnity payments to substitute for the additional borrowing and debt restructuring that would occur at relatively high interest costs in years of low crop yields without the use of insurance.

The addition of the lenders' response in scenario 3 resulted in lower and less stable profitability measures compared with the results for scenario 2, but it produced stronger profit performance compared with scenario 1. The stabilizing effects of crop insurance remained beneficial, but the model farm's tendency to use the additional borrowing capacity for financing purposes at high interest costs in low yield years had an

[6]The prices were generated with the FAPSIM model, an aggregate economic forecasting model currently used by USDA's Economic Research Service. The price projections provided by the model covered the first five years of the simulated horizon. Subsequent price projections were estimated by adding to the fifth year prices annual increments of $0.12 per bushel for corn and $0.05 per bushel for soybeans according to trend values found in an earlier study by Aukes.

Table 4. Performance Measures for Solvent Runs of the Simulation Analysis Classified by Variability Region and Crop Insurance Scenario

	Low Variability Region Scenario**			High Variability Region Scenario**		
	1	2	3	1	2	3
Net present value						
Mean, $	313,864	330,468	321,374	224,927	240,580	232,833
Coefficient of variation, %	36.3	31.3	34.0	33.5	28.0	29.8
Present value, ending net worth						
Mean, $	337,687	349,340	340,248	184,877	197,559	189,813
Coefficient of variation, %	33.8	29.6	32.1	40.8	35.2	36.5
Profit index						
Mean	4.0	4.2	4.1	4.3	4.6	4.4
Coefficient of variation, %	27.2	23.8	25.6	25.8	22.6	23.1
Ending cash reserve						
Mean, $	460,684	481,904	473,326	269,227	303,546	284,769
Coefficient of variation, %	68.0	59.4	62.3	72.9	60.5	63.8
Ending equity-to-assets ratio	.751	.770	.750	.770	.788	.778
Probability of survival						
Base model	.580	.710	.750	.450	.620	.720
Lower initial debt	NA*	NA	NA	.710	.900	.950
Higher commodity prices	NA	NA	NA	.860	1.000	1.000
Lower insurance premiums	NA	NA	NA	.480	.680	.760

* No runs were attempted for the low variability region using the secondary scenarios.

** Scenarios 1, 2, and 3 contained a reduction in initial indebtedness, an increase in commodity prices, and a reduction in crop insurance premiums, respectively.

off-setting effect on profits. In both variability regions, the mean values of the ending cash reserves and the equity-to-asset ratios also were lower in scenario 3 than in scenario 2. However, the lender response together with insurance did have a positive effect on the farm's survival prospects; the probabilities of survival increased to .750 and .720 for the low and high variability regions, respectively. Thus, compared with scenario 2, crop insurance and the lender response improved survival prospects through greater borrowing at interest costs high enough to diminish expected profitability.

To test the sensitivity of the model results, three of the major parameters of the farm situations were varied, and the simulation model was rerun for the high variability region because it had the greater number of insolvencies over the model horizon. The first secondary scenario involved a reduction in the farm's initial indebtedness to yield a beginning equity-to-asset ratio of .45. The concern here was that excessively high initial debt levels could have caused substantial insolvencies regardless of the risk responses used. The second secondary scenario involved an increase in commodity prices by 25 percent in all years of the horizon. If the high incidence of insolvencies reflected the farm's inability to generate enough revenue to cover all fixed and variable costs, then that chronic condition could make the use of crop insurance ineffective under any condition. The third secondary scenario involved a reduction in crop insurance premiums by 75 percent. That change was intended to test the relative effects of the premium levels on the survival rates relative to the other specifications on indebtedness and commodity prices.

As shown in the last three rows of Table 4, each of those changes yielded the anticipated increase in probabilities of survival. Although the magnitudes of change in the different parameters are not directly comparable, it is still noteworthy that the survival rates responded most to the increase in commodity prices and least to the reduction in crop insurance premiums reflecting the narrow range in possible changes of insurance costs. The strong survival response to the reduction in indebtedness relative to the base scenarios also showed that the use of crop insurance together with the lender responses may significantly benefit farms differing from the initial model farm only by a stronger financial position.

Concluding Comments and Implications

The survey and simulation procedures used in the study proved effective in eliciting the lenders' responses to crop insurance and in evaluating their effects on farm financial performance in the two variability regions. In general, the survey results indicated that borrowers typical of the case situations analyzed here could anticipate a positive, yet moderate response from approximately 60 percent of their nonreal estate lenders as a result of participating in the Federal Crop Insurance program. However, the magnitude of the response would differ considerably among lenders and would occur primarily as an expansion of the amount of available credit for nonreal estate purposes, with little if any change in interest rates, loan maturities, or other loan terms. Regional differences in yield variability did not appear to be a major factor in the magnitude or form of the lender response for operating credit, although a stronger response in the availability of capital credit occurred in the high variability region. The incidence and magnitude of the credit responses also appeared to differ by type of lender, although the small number of PCAs responding to the survey limits the conclusiveness of that finding.

The results suggested that the farmer's use of crop insurance, at least from the lenders' viewpoint, could reduce the farm's business risk enough to allow higher financial risk arising from the greater amount of credit made available to borrowers. The higher financial risk would materialize if borrowers increased their use of borrowed funds in response to using crop insurance; alternatively, the farm's liquidity position could improve due to the greater accumulation of financial and credit reserves. The results of the simulation analysis were consistent with those observations. In both variability regions, the use of crop insurance alone increased the expected level and stability of the farm's profitability, contributed to greater liquidity, and increased the probabilities of survival. When both crop insurance and lender responses were considered, the profitability and liquidity measures were

reduced, although not to the base levels with no use of insurance, and the probabilities of survival increased. Thus, for the particular specifications of the model farms, the lender response to crop insurance allowed additional borrowing to enhance survival prospects, although at higher interest costs and at reduced profit levels. In subsequent sensitivity analysis, the survival rates increased further in response to lower levels of initial indebtedness, to reductions in crop insurance premiums, and especially to revenue increases from higher commodity prices. Thus, crop insurance may have considerable merit when it is combined with other management or policy actions that reduce indebtedness or increase revenues for highly leveraged, low equity crop farms.

Those findings, including the disparity of responses among lenders, suggest a strong need for and potentially high payoff from continued educational efforts directed at both lenders and farmers, especially if the Federal Crop Insurance Corporation continues calculating premium rates, yield coverage percentages, and actuarial rates in the same way. While the protection provided by crop insurance is less tangible and more difficult to measure than the explicit costs of insurance premiums, the risk reduction can be especially important for farmers with relatively high leverage and significant vulnerability to stress conditions. Utilizing insurance likely is a more efficient way to provide liquidity than is relying on public credit or other types of financial assistance when adverse events occur. Moreover, as the findings show, using insurance can add to the liquidity provided by credit reserves as well.

Several qualifications should be cited about the interpretation of the results. Participation in crop insurance was the primary form of risk response followed by the model farms, and yield variability was the sole source of risk. In practice, of course, farmers experience numerous sources of risk and would utilize other types of risk response in addition to or in place of crop insurance. Moreover, lenders would respond in nonprice and/or price terms to the full set of farmers' actions in producing and marketing their crops, managing their cash flows, and capitalizing their farming operations. Thus, the emphasis placed in this study on crop insurance and credit may have overstated their usefulness as risk responses compared with the wider set of risk responses employed by farmers. But, the focus on crop insurance was needed in order to observe its fundamental effects on low equity, highly leveraged farms during an era of financial stress in agriculture.

Other qualifications involve the implications of using the steady size state for the farm, the use of normal crop distributions—both of which were discussed earlier—and the financial conditions prevailing at the time of the survey. The lender responses clearly occurred in the context of the financial stress conditions of the 1980s. In other economic times when financial stress is less severe, the credit responses of lenders could be lower as well. Finally, a broader geographic scope for this type of study could further generalize the results to farm situations with other levels of yield risk and structural characteristics. While the differences in yield variability within Illinois are important, the relative levels of variability may be modest compared with other regions. Thus the approach followed in this study could be applied to other regions as well. It is likely, for example, that the credit responses and financial effects of crop insurance would be stronger in regions experiencing greater yield risk than Illinois.

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Impacts of Production Credit Association Capitalization Policies on Borrowers' Costs

Bruce L. Jones and Peter J. Barry

Abstract

Production Credit Associations (PCAs) are farmer-owned cooperatives that are intended to enhance in part the economic well-being of American farmers and ranchers by decreasing and stabilizing the cost of credit services. Measuring the financing costs of PCA borrowers is complex because borrowers are investors in and patrons of the PCA. Thus, borrowers' financing costs should be the net of the returns the borrowers receive as investors. This study expresses the actual PCA borrower's costs in terms of the interest rate that equates to zero the net present value of the cash flows associated with a PCA loan.

A stochastic, multiperiod simulation analyzed the impacts of various capitalization methods on the level and the stability of borrowers' costs. The simulation results suggest that PCAs with different risk and return preferences will prefer different capitalization methods.

Key words: finance, cooperatives, risk, production credit associations.

According to the Farm Credit Act of 1971, Production Credit Associations (PCAs) are farmer-owned cooperatives that, as part of the Cooperative Farm Credit Survey, are ". . . designed to accomplish the objective of improving the income and well-being of American farmers and ranchers by furnishing sound and constructive credit to them . . ." For farmers, that objective is met in part by keeping the level and variability of borrowing costs as low as possible. The acquisition and management of equity capital is a component of the PCA operations that can have significant effects on the level and the variability of borrower costs.

PCAs acquire and manage two general forms of equity capital: stock and retained surpluses. A PCA accumulates stock by requiring patrons to purchase stock at a specified rate per dollar value of loan. Retained surpluses are analogous to the retained earnings of a noncooperative business; they are the accumulated after-tax operating surpluses a PCA retains from net earnings after payments of dividends and/or patronage refunds. Retained surpluses are affected by the dividend and patronage refund policies of a PCA as well as by the spread between the contract interest rate charged on loans and the association's cost for borrowed capital.

Observation of the 1982 stock rates, spreads, dividends, and patronage refunds for the forty-three PCAs supervised by the St. Louis Federal Intermediate Credit Bank (FICB) indicated a wide variety of capitalization methods. For example, the mean and the standard deviations of the spread for those PCAs were 1.27 percent and .65, respectively, and the mean and the standard deviations of the December 31 B-stock rate were 12.20 percent and 3.16, respectively. Dividends were paid by only seventeen PCAs in 1982,

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and only nine of the forty-three PCAs paid patronage refunds.

The diversity in capitalization activities by PCAs causes concern because all the associations are presumably attempting to achieve the objective cited earlier. Moreover, no prior analyses have evaluated the impacts of alternative capitalization methods on borrowers' costs. It is possible that some PCAs have used capitalization methods that are not compatible with their mandated objectives. Therefore, further information is needed about the effects of capitalization methods on the level and the stability of borrowers' costs.

This study's objectives are: (a) to conceptualize and to model the intermediation process performed by PCAs using stochastic simulation procedures, (b) to use the model to evaluate the effects of alternative capitalization methods on the level and stability of borrowers' cost and the financial conditions of the PCAs, and (c) to evaluate the model and the capitalization methods under different economic scenarios. In the following sections the authors review previous studies, show the model specifications, report results, and consider their implications.

Previous Studies

Studies focusing on the Farm Credit System (FCS) and PCAs are well documented in the agricultural finance literature (Brake and Melichar). Many studies provide both a descriptive and an analytical framework for evaluating those institutions. Frey and Lins described the flow of loan funds from national money markets to farmers and ranchers, and Smith, Bildersee, Tauer and Boehlje, as well as Morris addressed some of the FCS banks' financing problems. Osburn and Hurst examined economies of size in PCAs, and Sundell and Tiegen identified factors that affect the contract interest rates charged by PCAs. Relationships between borrower characteristics and PCA loan quality were identified by Dunn and Frey, and Lee, Marsh, and Meyer.

None of the numerous studies of PCAs have specifically addressed capitalization methods; however, the theories and procedures of other studies focusing on capitalization issues for nonfinancial cooperatives are relevant here. In an earlier analysis Fenwick considered minimum cost methods of cooperative capitalization subject to achieving other performance standards. Fenwick assigned costs to cooperative equity capital reasoning that patron-members incurred opportunity costs on that capital. Using data from a 1960–70 test period and a linear programming model that simulated a cooperative's operations and minimized capital costs, Fenwick determined that cooperatives could reduce capital costs by using more debt and accelerating the payment of deferred patronage refunds. In a similar study of Wisconsin supply cooperatives, Dahl and Dobson used recursive linear programming to show that cooperatives could reduce capital costs by accumulating more equity in the form of stock rather than as retained surpluses.

In another capitalization analysis Bierlein and Schrader simulated a cooperative's operations for a twenty-year period to measure: (a) the present values of the annual cash refunds to member patrons, (b) the cooperative's beginning equity position, and (c) the present value of the cooperative's equity position in the twentieth year. Bierlein and Schrader considered both the patron's opportunity cost for capital and the potential future benefits for member patrons. They concluded that the greatest net present value for patron benefits came from the cooperative's accumulation of equity rather than borrowed capital.

None of those studies considered the effects of risk on optimal capitalization activities. The findings may have differed under conditions of risk, as occurs here.

The PCA Model

To develop the analytical framework, the PCA is modeled as an economic unit that maximizes expected utility on behalf of its member-patrons where the expected level and the variance of borrowers' interest rates are the determinants of expected utility. Thus the conceptual model is developed as follows:

$$E(U) = \alpha[E(AIR), V(AIR)] \quad (1)$$
$$E(AIR) = \beta[c, N, X, E(f)] \quad (2)$$
$$V(AIR) = \gamma[c, N, X, V(f)] \quad (3)$$

where

$E(U)$ = the collective expected utility of the borrowers,
$E(AIR)$ = the expected value of the net after-tax interest rate (AIR) for the borrowers,
$V(AIR)$ = the variance of the AIR,
c = the vector of the capitalization variables controlled by the PCA,
N = the vector of endogenous variables that comprise the environment of the PCA,
X = the vector of exogenous variables that comprise the uncontrollable environment of the PCA,
$E(f)$ = the expected value of the interest rate the PCA pays on the capital it borrows,
$V(f)$ = the variance of the interest rate the PCA pays on borrowed capital,
α = the function that transforms $E(AIR)$ and $V(AIR)$ into expected utility,
β = the function that transforms c, N, X, and $E(f)$ into $E(AIR)$,
γ = the function that transforms c, N, X, and $V(f)$ into $V(AIR)$.

The PCAs objective function (Equation 1) states that the collective expected utility of borrowers is a function of the expected level, $E(AIR)$, and variance, $V(AIR)$, of the borrowers' net after-tax interest rate. Both of those variables are inversely related to borrowers' expected utility, $E(U)$; that is, increases (decreases) in $E(AIR)$ and $V(AIR)$ cause $E(U)$ to decline (increase).

Because it is assumed that borrowers maximize expected utility, the PCA in turn seeks actions that contribute to that goal. Therefore one PCA action is preferred to another when either

$E(AIR1) < E(AIR2)$ and $V(AIR1) \leq V(AIR2)$, then the action resulting in $E(AIR1)$ is preferred to the action resulting in $E(AIR2)$; or
$E(AIR1) \leq E(AIR2)$ and $V(AIR1) < V(AIR2)$, then the action resulting in $E(AIR1)$ is preferred to the action resulting in $E(AIR2)$.

Equations 2 and 3 indicate that the $E(AIR)$ and the $V(AIR)$ are both functions of the capitalization method, the endogenous environment, and the exogenous environment of the PCA. Those equations also indicate that $E(AIR)$ and $V(AIR)$ depend on the expected value and variance, respectively, of the cost to the PCA of borrowed funds. Capitalization activities are the only decision variables affecting $E(AIR)$ and $V(AIR)$. Therefore, the PCA must manage those variables, under various environmental conditions, on behalf of its borrowers.

For this analysis the net after-tax cost of borrowing (AIR) is the discount rate that equates to zero the net present value of the after-tax cash flows associated with a PCA loan. Thus the AIR is analogous to an internal rate of return (IRR). It is an IRR to the lender, but not to the borrower. The total net present value (Equation 4) has four components: (a) the present value of the principal payments made by borrowers less the present value of the cash the PCA loaned to borrowers (Equation 5), (b) the present value of the after-tax interest payments made by borrowers (Equation 6), (c) the present value of the after-tax dividends and patronage refunds received by borrowers (Equation 7), and (d) the difference between the after-tax present values of the ending and beginning stock of surpluses held by the PCA (Equation 8). Those equations reflect the costs PCA borrowers incur as patrons (Equation 6) and the returns they experience as owners (Equations 7 and 8). Thus the AIR reflects the combined effects of the costs and returns that PCA borrowers experience when they borrow from their association.

$$NPV = RB + IP - DPR - RS \quad (4)$$

$$RB = \sum_{q=1}^{4} \left([CB_q \cdot DF_q] - [CB_{q-1} \cdot DF_{q-1}]\right) \quad (5)$$

$$IP = \sum_{q=1}^{4} \left([1-t] \cdot [f_q + s_q] \cdot [1/4] \cdot [CB_q/(1-b_q)] \cdot DF_q\right) \quad (6)$$

$$DPR = \sum_{q=1}^{4} \left([\,([1-t]\,DIV_q) + ([p_q - t]\,PR_q) + SAR_q] \cdot DF_q\right) \quad (7)$$

$$RS = \sum_{q=1}^{4} \left([([(1-t)SR_q] + SA_q) \cdot DF_q] - [([(1-t)SR_{q-1}] + SA_{q-1}) \cdot DF_{q-1}]\right) \quad (8)$$

where,

NPV = net present value of PCA loans,
RB = the present value of the borrowers' principal payments less the present value of cash borrowed from the PCA,

IP = the present value of the borrowers' after-tax interest payments,

DPR = the present value of after-tax dividends and patronage refunds received by borrowers,

RS = the difference between the after-tax present values of ending and beginning stock of retained surpluses for the PCAs,

DF_q = the discount factor for quarter q—$(1+[AIR/4])^{-q}$,

t = borrowers' marginal tax rate,

f_q = FICB interest rate in quarter q,

s_q = PCA spread in quarter q,

f_q+s_q = contract interest rate charged by the PCA in quarter q,

CB_q = average amount of cash loans outstanding to borrowers in quarter q,

b_q = B-stock rate in quarter q for the PCAs,

$CB_q/(1-b_q)$ = the average amount of total loans (cash + B—stock) outstanding to farmers in quarter q,

DIV_q = dividends received by borrowers in quarter q,

p_q = percentage of patronage refunds paid as cash in quarter q,

$0059PR_q$ = patronage refunds declared by the PCA in quarter q,

SAR_q = surplus allocated revolved to borrowers in quarter q,

SR_q = surplus reserve held by the PCA at the end of quarter q (never revolved to members),

SA_q = surplus allocated held by the PCA at the end of quarter q (eventually revolved to members).

Equation 5 represents the cash borrowed by farmers and eventually repaid to the PCA, and Equation 6 represents the interest payments on those loans. Equation 6 shows that the borrowers' interest payments rise (fall) when the FICB interest rate (f_q) or the PCA spread (s_q) increases (decreases). Equation 6 also shows that the PCA stock requirement (b_q) forces borrowers to pay interest on $\$(1/[1-b_q])$ for every borrowed dollar. Hence a higher stock rate increases the borrowers' interest expenses.

The returns that are revolved to PCA borrowers in the form of dividends, patronage refunds, and surplus allocated are shown in Equations 7 and 8. The other return to borrowers is the change in PCA retained surpluses (Equation 8). Borrowers experience positive (negative) returns as retained surpluses increase (decrease). The level of those surpluses is partially determined by the borrowers' interest payments. As interest payments increase, the PCA surpluses rise, increasing returns to borrowers. Thus Equations 6, 7, and 8 are interrelated because borrowers' interest payments partially determined the level of their returns. Furthermore the level of PCA surpluses is also partially determined by the stocks of surplus allocated and surplus reserve held by the association.

Greater accumulation of surplus allocated and surplus reserves enable the PCA to reduce its use of debt capital. As a result interest expense decreases, surpluses become greater, and returns to borrowers increase. Conversely if the retained surpluses of the PCA are depleted, more debt capital will be used and returns to borrowers will fall.

The Capitalization Variables

Six capitalization variables that determine the level and variability of AIR are identified in Equations 5 through 8: (a) stock requirements for loans, (b) the interest rate spread, (c) the timing of the collection of accrued interest from borrowers, (d) the dividend paid by the PCA, (e) the percentage of patronage refunds paid in cash, and (f) the length of the revolving period for deferred patronage refunds. The first three variables directly affect the level and timing of borrowers' interest payments; the other variables determine the level and timing of the cash flows to borrowers.

Both spread and stock requirements are positively related to borrowers' interest expense; increases (decreases) in either of those variables cause the AIR to rise (fall). The stock requirement directly affects the equity position of the PCA because much of its equity is stock. The spread indirectly affects the association's equity position through its effects on operating surpluses.

How frequently the PCA collects accrued interest from borrowers also affects the AIR. Quarterly versus annual collection is more

costly because borrowers forego the use of cash earlier and thus lose earnings on interim investments.

Dividends, patronage refunds, and revolvements of deferred patronage refunds also affect the AIR. Higher dividend rates and greater percentages of patronage refunds paid in cash decrease the AIR. Conversely lengthening the revolving period for deferred patronage refunds increases the AIR by reducing borrowers' annual cash receipts.

Capitalization decisions by the PCA also affect the variance of AIR. In general, V(AIR) will decline as the PCA generates cash and thus reduces its use of variable cost debt capital. Therefore high spreads and stock rates, low dividends and patronage refunds, and more frequent collection of accrued interest will stabilize borrowers' costs because those capitalization methods allow the PCA to reduce its use of debt capital. In contrast capitalization methods that increase the association's use of debt capital will increase the V(AIR).

Environmental Variables

The level and the stability of AIR are also affected by exogenous and endogenous variables. Some of the exogenous variables arise from competitive markets as with the level of loan demand, the FICB interest rate, salary levels, and rental rates on buildings and equipment. Others are attributed to institutional regulations as with tax requirements, limits on leverage and patronage refunds, and provisions for loan losses.

The FICB interest rate strongly affects both the level and the stability of AIR. That stochastic variable is affected by conditions in the national financial markets where the FICB obtains most of its loan funds. Other market-determined variables comprising the economic environment of the PCA are wages and salaries, rents on capital assets, and farmers' loan demands.

FICB and governmental regulations are also part of the exogenous environment of the PCA. For example, its leverage ratio (debt to equity) cannot exceed 7.50. In addition, the FICB determines how much of the association's interest expense is returned as a patronage refund each year. Governmental regulations affecting PCAs include: income tax obligations, maximum dividend rates (8 percent per annum), the minimum percentage (20 percent) of patronage refunds to be paid in cash to avoid tax obligations, the minimum and maximum allowable PCA stock rates (5 percent and 10 percent, respectively), the accumulation of provisions by a PCA for loan losses until they equal 3.5 percent of year end outstanding loan volume, and limitations on annual additions to provisions for losses of .5 percent of year end outstanding loans volume.

Endogenous environmental factors include the financial position of the PCA and financially related services for farmers and ranchers. The financial position is comprised of assets, liabilities, and equity at a point in time. Those factors depend at any time on past events and PCA actions; they represent the departure point for future operations. Financially related services like machinery leasing, insurance, and farm record keeping also influence the level of operating surpluses for a PCA and its financial structure.

The Analysis

The conceptual model was operationalized in order to perform stochastic simulations of PCA operations over twenty years to determine how various capitalization methods affect the level and the stability of borrowers' costs. The FICB interest rate was the stochastic variable for all simulations. That interest rate was specified in terms of means and variances for each simulation so that the model randomly drew quarterly FICB interest rate observations from the specified normal distributions.

The specifications of the model drew heavily on the previous modeling efforts by researchers at the St. Louis FICB. As in the St. Louis model, this study's model generates balance sheets that reflect the financial condition of the PCA over time. However, this study's model also measures the mean and the variance of the borrowers' costs over time.

Specifications

The general operating characteristics, capitalization methods, and economic

environment of the model PCA were specified for each simulation. Those specifications were either based on historic PCA operations data or on the recommendations of St. Louis FICB personnel.

General operating characteristics. The beginning financial position of the model PCA is shown by the balance sheet in Table 1. The leverage ratio of 4.5 to 1 and the outstanding loan volume of $36 million reflect average values for all Sixth Farm Credit District PCAs in 1982. The base level for financially related services income was specified as $89,375 (the average amount received by PCAs in 1982). The seasonality of quarterly lending was the same as the 1982 seasonal indexes for PCAs: (a) Quarter 1, .98; (b) Quarter 2, 1.02; (c) Quarter 3, 1.06; and (d) Quarter 4, .94. The collective marginal tax rate for borrowers was set at 30 percent.

Table 1: Beginning Balance Sheet Specifications for the Model PCA

Cash	39,596
Inv. in FICB	1,586,213
Acc. & Notes Rec.	31,947
Loans less PCOs	35,688,670
Sales contracts	0
Loans in liq/acq prop.	95,493
Provision for losses	1,249,103
Acc. int. rec.	2,007,131
Fixed assets	459,648
Other assets	5,269
Tax deposit—State	0
Tax deposit—Federal	0
Total Assets	38,664,864
Notes payable FICB	30,746,052
Accrued int. payable	835,065
Other liabilities	53,767
Total Liabilities	31,634,884
A-stock	107,000
B-stock	3,568,870
Other system capital	0
Surplus allocated	0
Surplus reserve	3,354,110
Accumulated earnings	0
Total equity	7,029,980
Total liab. & equity	38,664,864
Leverage	4.500000

To add realism, two other assumptions were arbitrarily made about the model PCA. First, purchases of fixed assets occurred in year three and year twelve producing cash outflows of $100,000 and $250,000, respectively. Second, loan losses of $500,000 and $1,250,000 were specified for year eight and year seventeen, respectively. The years of those events were selected arbitrarily.

Capitalization methods. Five of the six capitalization variables cited earlier were used in defining nine unique capitalization methods for the model association. The five variables are: spread, B-stock rate, timing of accrued interest collection, patronage refund payment methods, and revolvement of deferred patronage refunds. Because historic data indicated that PCAs typically do not pay dividends, FICB personnel suggested that dividends be excluded from the analysis. The nine capitalization methods are specified in Table 2.

Capitalization method 0 (CM-0) is the base method. For CM-0 the B-stock rate is 10 percent, accrued interest is collected annually, and patronage refunds are declared whenever operating surpluses exist with 20 percent of the refund paid in cash and the balance paid in equal installments over five years. The association's spread is adjusted annually so inflationary increases in variable operating expenses are offset by greater loan revenues (interest receipts). The inflation adjustment causes the spread to change in the following manner. If the spread in year one is 1.50 percent, and inflation is 6 percent, then the spread is 1.59 percent (1.50×1.06) in year two, 1.69 percent (1.59×1.06) in year three and so on. The adjustment process causes the nominal spread to increase, but the real spread is held constant.

A B-stock rate of 5 percent is the only difference between CM-1 and base method CM-0. The difference between CM-2 and the base method is the revolvement period for deferred patronage refunds. For CM-2 deferred patronage refunds are revolved over ten years with 1/20 of the deferred refund paid annually in years one through nine and 11/20 of the refund paid in year ten. CM-3 differs from CM-0 only in that no patronage refunds are deferred in CM-3. CM-4 differs from the base method in that accrued interest is collected quarterly in CM-4 versus annually in CM-0.

Table 2: Capitalization Methods Used for Simulations

Capitalization Methods	Equity Acquisition Variables			Patronage Refund Variables	
	Stock Rate	Spread[a]	Interest Collection[b]	% Paid in Cash	Revolving Period[c]
0	10	IAS	A	20	5
1	5	IAS	A	20	5
2	10	IAS	A	20	10
3	10	IAS	A	100	-
4	10	IAS	Q	20	5
5	10	CS	A	20	5
6	5	CS	A	20	5
7	10	IAS	A	-	-
8	10	CS	A	-	-

[a] IAS = Inflation-adjusted spread
CS = Constant spread
[b] A = Annually
Q = Quarterly
[c] 5 = Five-year revolving period
10 = Ten-year revolving period with payments based on twenty-year repayment plan

For CM-5 the nominal spread is constant for the entire simulation period, and the real spread decreases with inflation. The constant nominal spread and the inflation-adjusted nominal spread are specified to yield about the same total loan revenues over the entire simulation period, but the timing of the receipts differs. In years one through ten the constant nominal spread causes the loan revenues of the PCA to be greater than when the inflation-adjusted nominal spread is used. However, in years eleven through twenty the loan revenues for the constant nominal spread are lower than for the inflation-adjusted nominal spread.

CM-6 and CM-5 are identical with one exception: the B-stock rate is 5 percent for CM-6 versus 10 percent for CM-5. For CM-7 the PCA never declares or pays patronage refunds. All other specifications for CM-7 are the same as for CM-0. The only difference between CM-8 and CM-7 is that the nominal spread is held constant instead of annually adjusted for inflation.

Economic environment. The economic environment in the model PCA was specified in terms of the following variables: annual growth for loans outstanding, annual growth rate for financially related services income, inflation rate for variable operating expenses, FICB patronage refund rate, the expected value(s) for the FICB interest rate, and the variances(s) for the FICB interest rate. Historic data were the basis of the annual growth rate for financially related services, FICB patronage refund rates, and the variance(s) of the FICB interest rate. Projections made by the Farm Credit Administration for 1985 were used in formulating the annual rates for loan growth, inflation, and the cost of FICB funds (Project 1985). The model PCA was specified to operate under three economic scenarios that represent different expectations on one or more of the latter four economic variables.

For economic scenario 0 (ES-0) annual growth rates for loans and financially related services income are 5 percent and 3.75 percent, respectively; inflation is 6 percent; and the FICB annually refunds 8 percent of the association's interest expense. In addition, funds cost the FICB 9.75 percent and its spread is .75 percent; thus the expected interest rate for the FICB is 10.50 percent (9.75+.75). Because the variance of the FICB interest rate is 20.00, the coefficient of variation (standard deviation divided by mean) for the FICB interest rate is the same as in the 1958–82 period (mean = 6.72 percent, standard deviation = 2.88).

ES-1 differs from ES-0 in two ways. First, the FICB interest rate in ES-1 is 11.25 percent rather than 10.50 percent reflecting an increase in the FICB's spread of .75 percentage points. Second, the FICB patronage refund rate is 4 percent instead of 8 percent. Those changes reflect attempts by the FICB to generate and to retain greater

amounts of equity capital. Two conditions that could trigger the FICB response reflected by ES-1 are elimination of its tax exempt status or substantial increases in the potential for loan losses by PCAs.

For ES-0 the expected value and the variance of the FICB interest rate are constant over the entire simulation horizon. However, for ES-2 those variables change every 5 years. The changes reflect the results if financial conditions stabilized in precisely the same manner as they destabilized between 1963 and 1982. In addition, the inflation rates in ES-2 were adjusted to match the changes in interest rates because inflation and interest rates are considered closely related.

Procedures

The model was used to perform a set of fifty simulation runs for each PCA operating condition that was specified in terms of general operating characteristics, a capitalization method, and an economic scenario. A Monte Carlo approach was followed in randomly drawing quarterly FICB interest rate observations from a normal probability distribution(s). The distribution(s) remained stationary for all the simulation runs comprising the set. Thus, the FICB interest rate observations differed for each simulation run, but all the observations were drawn from the same probability distribution(s).

The model computed the AIR for each year of a simulation run. The model then used those annual AIRs to compute the mean and the variance of the AIR for the period simulated (E(AIR) and V(AIR), respectively). Next, the model used the E(AIR) and the V(AIR) for each simulation run comprising a set to compute: the mean of the E(AIR)s, $\overline{E(AIR)}$; and the mean of the V(AIR)s, $\overline{V(AIR)}$. The $\overline{E(AIR)}$s and the $\overline{V(AIR)}$s associated with each capitalization method were then evaluated using the risk efficiency criteria previously discussed. The evaluation was performed to determine the relative preferability of each capitalization method.

For each set of simulation runs the model also computed the mean of the twentieth year leverage positions (LEV) for the model PCA. The LEV value was compared with discretionary and legal limits on leverage in evaluating the financial feasibility of the various capitalization methods. FICB regulations state that if an association's leverage exceeds 7.5 to 1, then its loan discounting privileges are revoked. Keeping the leverage lower than 7.5 in normal years was considered a logical response to that restriction. Thus, a discretionary leverage limit of 6.0 was stipulated. A capitalization method yielding a value for LEV greater (less) than 6.0 was deemed financially infeasible (feasible). That specification served as the PCA budget constraint.

The nine capitalization methods and the three economic scenarios made it possible to simulate twenty-seven different PCA operating conditions. However, the high cost of running the simulation model made it infeasible to evaluate all operating conditions. All nine capitalization methods were simulated under ES-0; then the resulting values for the $\overline{E(AIR)}$s, $\overline{V(AIR)}$s, and LEVs were used to identify four financially feasible capitalization methods that were risk-efficient and/or representative of historic PCA capitalization methods. Those methods were then simulated under ES-1 and ES-2 to yield eight additional sets of E(AIR), V(AIR), and LEV for evaluation.

Results

Table 3 indicates the results for $\overline{E(AIR)}$, $\overline{V(AIR)}$, and LEV for the seventeen sets of simulations. The third, fourth, and fifth columns of the table present the results for the ES-0, ES-1, and ES-2 conditions, respectively.

Results for ES-0

Three capitalization methods yielded values of LEV greater than 6.0 and were deemed infeasible: CM-1 (5 percent B-stock rate), CM-5 (constant nominal spread), and CM-6 (5 percent B-stock rate and constant nominal spread). Those findings suggest PCAs can not simultaneously pay patronage refunds and use low spreads and stock rates under ES-0 conditions; doing so will jeopardize their financial positions by not allowing sufficient accumulation and retention of equity capital under the stochastic interest rate conditions.

The $\overline{E(AIR)}$s and $\overline{V(AIR)}$s for the six feasible capitalization methods indicate three dominant ones in terms of risk efficiency. As

Table 3: Results of the Simulations

Capitalization Method	Variable	Values of $\overline{E(AIR)}$s, $\overline{V(AIR)}$s, and LEVs for:		
		Economic Scenario 0	Economic Scenario 0	Economic Scenario 0
(1)	(2)	(3)	(4)	(5)
0	$\overline{E(AIR)}$	9.96	10.54	8.37
0	$\overline{V(AIR)}$	3.05	3.12	.69
0	LEV	3.64	4.54	4.51
1	$\overline{E(AIR)}$	9.92	-	-
1	$\overline{V(AIR)}$	2.95	-	-
1	LEV	6.54	-	-
2	$\overline{E(AIR)}$	10.08	-	-
2	$\overline{V(AIR)}$	5.33	-	-
2	LEV	3.00	-	-
3	$\overline{E(AIR)}$	9.90	10.62	8.33
3	$\overline{V(AIR)}$	3.14	3.26	.75
3	LEV	3.70	4.62	4.52
4	$\overline{E(AIR)}$	10.06	-	-
4	$\overline{V(AIR)}$	3.55	-	-
4	LEV	3.44	-	-
5	$\overline{E(AIR)}$	9.94	-	-
5	$\overline{V(AIR)}$	3.04	-	-
5	LEV	6.21	-	-
6	$\overline{E(AIR)}$	9.94	-	-
6	$\overline{V(AIR)}$	3.19	-	-
6	LEV	37.34	-	-
7	$\overline{E(AIR)}$	10.35	10.98	8.56
7	$\overline{V(AIR)}$	3.65	3.51	.85
7	LEV	2.75	3.16	3.64
8	$\overline{E(AIR)}$	10.40	10.95	8.81
8	$\overline{V(AIR)}$	2.62	2.75	1.31
8	LEV	3.32	3.79	4.35

Table 3 indicates, CM-0 and CM-3 (100 percent payments of patronage refunds in cash) are both preferred to CM-2 (ten-year revolvement of deferred patronage refunds), CM-4 (quarterly collection of accrued interest), and CM-7 (payment of no patronage refunds). The latter three methods cause the $\overline{E(AIR)}$ and $\overline{V(AIR)}$ to be greater than those for either CM-0 or CM-3. Thus, for ES-0 economic conditions, borrowers will prefer the borrowing costs arising from CM-0 or CM-3 to CM-2, CM-4, or CM-7.

The third risk-efficient method for the base case was CM-8 (payment of no patronage refunds and a constant nominal spread). Financing costs for borrowers were highest but most stable for CM-8 because the PCA was retaining operating surpluses instead of paying patronage refunds. That action allowed the PCA to reduce its own indebtedness, and borrowers' costs were insulated from FICB interest rate variations. No patronage refunds were paid in CM-7, but borrower costs were less stable than for CM-8 because the spread was annually adjusted for inflation in CM-7 but held constant in CM-8. That indicates that under ES-0 conditions, borrowers' costs will be more stable when spread is held constant over time instead of annually adjusted for inflation.

Payment of 100 percent of patronage refunds in cash (CM-3) yielded the lowest, least stable borrower costs because the PCA retained no operating surpluses in any year and thus made greater use of variable cost

FICB funds. CM-0 increased and stabilized borrowers' costs relative to CM-3 because deferred patronage refunds were revolved to borrowers over five years. That action allowed the PCA to use fewer FICB funds than occurred under CM-3. Those results suggest that borrowers' costs increase, then stabilize when patronage refunds are revolved over five years instead of paid immediately in cash.

The $\overline{E(AIR)}$s and $\overline{V(AIR)}$s for CM-0 and CM-4, respectively, indicate that quarterly collection of accrued interest from borrowers (CM-4) increases and destabilizes financing costs relative to annual collections (CM-0). The CM-4 $\overline{E(AIR)}$ is higher because when interest is collected more frequently borrowers forego the use of cash more quickly and for a longer period of time. Borrowers' costs are also less stable for quarterly collection of interest because interest payments are affected by changes in FICB interest rates four times a year instead of once a year.

As stated earlier, the capitalization method selected by the PCA depends on the preferred trade off between the level and the stability of borrowers' costs. The more risk averse PCA might select CM-8 or a similar method because it results in the lowest value for $\overline{V(AIR)}$. CM-0 might be preferred by a PCA with an intermediate risk aversion, and CM-3 might be selected by a less risk averse association that is more concerned with keeping borrowers' costs low.

Results for ES-1 and ES-2

The three capitalization methods (CM-0, CM-3, and CM-8) that were financially feasible and risk-efficient for ES-0 were also evaluated using ES-1 and ES-2. In addition, CM-7 was evaluated under those scenarios because it resembled the capitalization method typically used by Sixth District PCAs from 1977 through 1982 (payment of no patronage refunds and annual adjustment of spread). CM-0, CM-3, CM-7, and CM-8 are not necessarily the "best" capitalization methods for either ES-1 or ES-2. Other specified capitalization methods could also be risk-efficient and financially feasible for those scenarios. But the other methods were not analyzed.

Scenario ES-1 is characterized by higher cost FICB funds and lower patronage refunds paid by the FICB. The high cost of funds causes the $\overline{E(AIR)}$s for ES-1 to exceed those for ES-0, and the lower rate of patronage refunds increases LEV relative to the base scenario result. Despite the higher leverage, all four capitalization methods are financially feasible for ES-1. However, only CM-0 and CM-8 are risk-efficient. CM-7 has a greater $\overline{E(AIR)}$ and $\overline{V(AIR)}$ than does CM-8. Similarly CM-0 has lower, more stable borrower costs than CM-3.

As with ES-0, the $\overline{E(AIR)}$s are nearly the same under ES-1 when no patronage refunds are paid (CM-7 and CM-8). However, the relationship between the $\overline{E(AIR)}$s for CM-0 and CM-3 under ES-1 is exactly the opposite of ES-0. For the base scenario the CM-0 $\overline{E(AIR)}$ exceeds the $\overline{E(AIR)}$ associated with the payment of 100 percent of patronage refunds in cash (CM-3), but the reverse occurs for ES-1. That finding suggests that when the cost of FICB funds is rising and FICB patronage refunds are declining, the PCA should initiate a policy of revolving deferred patronage refunds (CM-0) instead of paying 100 percent of patronage refunds immediately in cash (CM-3). That action allows the PCA to reduce its use of FICB funds and thus lower costs for borrowers compared with the full payment of patronage refunds in cash and the relatively greater use of FICB funds.

For ES-2 the level and variability of the FICB interest rate decreased in exactly the same manner that they increased from 1963 through 1982. The spread specification for CM-8 was increased from 2.69 percent to 3.40 percent so the constant nominal spread for CM-8 is nearly the same as the average inflation adjusted spread for CM-0, CM-3, and CM-7. That procedure is also used in specifying the CM-8 spread for the other two scenarios.

All values for LEV are less than 6.0 for each capitalization method under ES-2. Thus CM-0, CM-3, CM-7, and CM-8 are all financially feasible for ES-2 conditions. As with the other scenarios, the base capitalization method (CM-0) is included in the risk-efficient set. The other risk-efficient method is CM-3 in which all patronage refunds are immediately paid in cash. Those two methods dominate CM-7 and CM-8 in which no patronage refunds are paid. The findings indicate that

when interest rates are falling and becoming more stable, borrowers' costs will rise and destabilize if patronage refunds are not paid from operating surpluses. It suggests that when ES-2 conditions exist, a PCA could respond to lower and more stable FICB interest rates by increasing leverage, thus causing borrowers' costs to decrease and stabilize.

Conclusions

Through this study, a conceptual framework of PCA operations has been developed that can be used in analyzing an association's financial operations. Furthermore, the study's conceptual framework is applicable to other units of the Cooperative Farm Credit System. Thus, the study has yielded an educational and analytical tool that can be used in evaluating the capitalization methods of any credit cooperative.

The study's results confirm that PCAs can manage the level and the stability of borrowers' costs by implementing various capitalization methods. In addition, the study's results indicate that risk-efficient capitalization methods for one set of economic conditions are not necessarily risk-efficient for a different set of economic conditions. That finding is important because it suggests that PCAs may have to alter their capitalization methods in response to changing economic conditions.

At this time PCAs are facing a highly uncertain financial environment. Interest rates could remain volatile. The Farm Credit System could lose agency status and/or tax-exempt status. Losses on loans could continue to increase dramatically as farmers' incomes and net worths decline. In many of the farm credit districts PCAs are being restructured and consolidated, in some cases into a single district-wide PCA with branches or "service centers" replacing the former separate entities. In addition a significant move is underway within the system to create common geographic boundaries and management for the local units of the PCAs and Federal Land Banks. Many of those changes are intended to make management practices and capitalization methods more uniform and to mobilize reserves against loan losses. All of those events have a substantial impact on management of the system's equity capital and thus on the level and stability of borrowing costs for customers.

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Financial Stress for the Farm Credit Banks: Impacts on Future Loan Rates for Borrowers

Peter J. Barry

A loan-pricing model is used to estimate the effects of financial stress on borrowing costs from the Farm Credit Banks during an adjustment period in which the banks restore their capital structure and repay any federal assistance. The magnitude and the duration of higher borrowing costs depend on the level of loan loss, leverage targets, the adjustment period, earnings on reserves, public subsidies, and other environmental changes. For example, an adjustment period of at least ten years would keep the increment to loan rates under 1.5 percent for losses up to about $4 billion.

Key words: Farm Credit System, interest rates, financial stress, public credit.

The financial assistance program enacted in December 1985 for the Cooperative Farm Credit System (FCS) empowers, but does not require, the U.S. Treasury to purchase obligations issued by the newly formed Farm Credit System Capital Corporation as a means of responding to the system's financial stress. Prior to passage of the act (the Farm Credit Amendments Act of 1985) much discussion focused on the strength of the system's own reserves and on making financial assistance contingent on the use of such reserves. While some observers believe that the FCS has adequate reserves to cope with financial stress, others believe that assistance programs should be established on a contingent basis in case farm financial conditions continue to deteriorate. The final legislation represents a compromise between the two views. It authorizes assistance upon certification by the Farm Credit Administration that the FCS has committed its available capital surplus to meet the financial stresses of the FCS institutions without keeping those institutions from making credit available to eligible borrowers on reasonable terms, without jeopardizing the access by the FCS to funds in the public financial markets, and without impairing the borrowers' stock.

A shortsighted feature of the debate about financial assistance for the FCS was the lack of attention to how the system will restore its soundness when financial conditions in agriculture improve and to the resulting cost implications for the system's borrowers. If the system employs its own reserves to the point where its capital surplus is substantially reduced or even depleted, then it must eventually rebuild its reserves position and restore its financial structure to some longer term target, or equilibrium, position. Alternatively, if financial assistance provided

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by the federal government is to be repaid in the future, then the FCS must generate the funds to meet the obligation. In either case the sources of funds needed to rebuild capital or to repay financial assistance must ultimately come from net earnings on loans. The net effect then is higher cost of funds for the associations, farmers, agricultural cooperatives, other financial institutions (OFIs), and others who borrow from the Farm Credit Banks.

In this article a loan pricing model is developed to estimate the effects of different levels of financial stress on the cost of loan funds for borrowers from the Farm Credit Banks. The major focus is on the changes in the cost of loan funds resulting from the increments to bank earnings that will be needed either to restore capital to acceptable levels or to repay public assistance. In the following sections the aggregate financial structure of the Farm Credit Banks is reviewed, the loan pricing model is developed and numerically specified, and the effects on borrowers' lending costs are estimated for different responses to financial stress and for differences in the Farm Credit Banks aggregate leverage position.

Financial Conditions of the Farm Credit Banks

Tables 1, 2, and 3 report the combined measures of the thirty-seven Farm Credit Banks' balance sheets, income statements, and selected financial ratios for year end 1982 through the third quarter of 1985. Those data come from the annual and quarterly (beginning in 1985) *Reports to Investors* published by the Federal Farm Credit Banks' Funding Corporation. Prior to 1986, data for Production Credit Associations (PCAs) and Federal Land Bank Associations (FLBAs) were not included in those figures because those associations are not directly liable for the farm credit bonds and discount notes. Nonetheless, many of the associations have experienced considerable difficulty and are drawing capital infusions from their district banks to continue operating. Their losses will eventually affect the financial conditions of the district banks.

As the data show, the overall strength of the Farm Credit Banks remained relatively strong until 1985, although still showing a downward trend. While loan quality was deteriorating and loan losses were mounting,

Table 1. Farm Credit Banks Combined Balance Sheet, Year End

	1982	1983	1984	1985*
		(million $)		
Assets				
Loans less loss allow.	77,876	78,462	77,089	70,742
Investment sec. & cash	3,115	2,513	3,416	5,294
Accrued interest	3,744	3,502	3,480	3,170
Property, less dep.	389	450	525	630
Other property	35	122	321	694
Total assets	85,159	85,049	84,831	80,530
Liabilities				
Consolidated sys. bonds	63,175	62,850	62,071	56,055
Con. bonds & others	7,972	5,182	5,231	4,771
Consolidated notes	1,856	4,783	4,890	7,461
Other liabilities	3,579	3,265	3,397	3,700
Total liabilities	76,582	76,080	75,589	71,987
Capital				
Capital stock & part. cert.	4,979	5,058	5,141	4,916
Surplus	3,598	3,911	4,101	3,627
Total capital	8,577	8,969	9,242	8,543
Liabilities and Capital	85,159	85,049	84,831	80,530

*Data for 1985 are for September 30, 1985.

Table 2. Farm Credit Banks Combined Income Statement

	1982	1983	1984	1985*
		(million $)		
Interest income				
Interest on loans	9,944.5	8,856.6	9,106.0	6,385.5
Interest on invest. sec	375.5	239.6	285.0	248.8
Total interest income	10,320.0	9,096.2	9,391.0	6,634.3
Interest expense				
Interest on bonds & notes	9,034.0	8,124.7	8,376.6	5,789.2
Other interest	95.2	69.9	84.0	82.2
Total interest	9,129.2	8,194.6	8,460.6	5,871.4
Net interest income	1,190.8	901.6	930.4	762.9
Provision for loan losses	74.7	38.8	121.0	675.9
Net int. inc. after loss prov.	1,116.1	864.8	809.4	85.0
Other income	250.2	76.7	69.7	74.5
Other expenses				
Personnel compensation	121.8	136.6	156.8	123.5
Fin. assist. to assoc.				163.2
Occupancy, eqpt. & other	101.7	117.3	154.8	184.6
Compensation to assoc.	148.9	144.8	125.8	114.4
Total expenses	372.4	398.7	437.4	585.7
Net income	993.9	542.8	441.7	(426.2)

*Data for 1985 are for September 30, 1985.

Table 3. Farm Credit Banks Financial Ratios

Item	1982	1983	1984	1985*
Net income to total assets	1.19	0.64	0.52	-0.57
Net income to equity capital	12.34	6.19	4.85	-6.27
Capital to assets, %	10.07	10.55	10.89	10.57
Liabilities to capital, %	8.93	8.48	8.18	8.18
Allow. for loan loss to loans	0.81	0.84	0.90	1.52
Net charge-offs to loans	0.02	0.01	0.16	0.56
Loan interest to total loans		11.33	11.71	11.52
Security interest to total sec.		8.51	9.61	7.62
Interest cost to liabilities		10.74	11.16	10.61

*Data for 1985 are for September 30, 1985.

the net charge-offs remained far below the banks' total accumulated provision for loan losses. Ratios of net income to average total assets and to average capital show a downward trend compared with 1982 levels (and compared with levels from 1979 through 1981 as well), but those profitability measures still remained positive. Moreover, the aggregate debt-to-equity ratio was trending downward as well due in part to slower loan growth in 1982 and 1983 and then to declining loan volumes in 1984 and 1985. That trend actually began earlier as indicated by year end debt-to-equity ratios of 10.83 in 1979, 10.57 in 1980, 10.06 in 1981, 8.93 in 1982, 8.48 in 1983, and 8.18 in 1984.

Thus, during the early 1980s the Farm Credit Banks in aggregate were able to strengthen their capital structures through relatively high earnings and lower leverage during a time of sharp recession in both the general economy and the agricultural sector.

Eventually, however, the adversity of its borrowers reached the FCS, and during the mid-1980s the Farm Credit Banks' financial positions deteriorated significantly. Special financial assistance packages were needed for two of the Federal Intermediate Credit Banks, and numerous other changes occurred in personnel, consolidation of management and associations, restructuring

of operations, and regulatory authority. Then, for the first three quarters of 1985, the thirty-seven banks reported a combined net loss of $426.2 million with most of the decline in income occurring during the third quarter.[1] The rates of return on assets and equity declined accordingly. The net loss in the third quarter of 1985 was due primarily to a sharp increase in the provision for loan losses, especially in the FLBs, and to financial assistance provided to troubled PCAs. Net interest income still had increased during the first three quarters of 1985 due to reductions in interest rates on farm credit bonds and discount notes and to upward pressure on loan rates to borrowers in order to cover greater lending risks and higher loss rates. Loan volume was declining although equity capital declined as well due to the negative net income and to reduced stock holdings by borrowers as their credit use declined. As a result, the aggregate leverage position of the Farm Credit Banks remained similar to its 1984 level.[2]

Projections for the future have received considerable attention by policy makers, the lending community, the media, and others. Opinions have been wide-ranging, and establishing a factual base for making accurate projections is difficult. According to the September 30, 1985, *Report to Investors*, the Farm Credit Banks' loans in a nonaccrual status had increased to $3.5 billion, or 4.9 percent of loans outstanding.[3] Other property acquired as a result of loan foreclosures increased to an end-of-quarter total of $694 million. Moreover, a special credit review of the Federal Land Banks indicated that about $6 billion of their $48 billion of loans outstanding are currently undercollateralized to the extent that the loan amounts exceed the current estimated market value of the real estate collateral.[4] The *Report to Investors* further projected that the Farm Credit Banks may be exposed to loan losses totaling $3 billion or more during the 1985–87 period as a result of the continuing deterioration of farm income and land values.

Moreover, in other media reports FCS officials have projected that nonaccrual loans and acquired property could reach $6 billion by mid-1986 and $10 billion to $12 billion by year end 1987 (*Wall Street Journal*; Fredrickson). Those loss figures combined with additional operating losses could lead to cumulative totals that would wipe out the Farm Credit Banks' capital surplus and loan loss reserves by year end 1987.

Those conditions prompted the passage by the U.S. Congress in December 1985 of the Farm Credit Amendments Act of 1985 that, among other provisions, is to provide the FCS with backup financial support from the federal government. In turn, the projected loan loss levels and the magnitude of possible federal assistance raise the concerns about the impact on the banks' future pricing policies and loan rates for agricultural borrowers resulting from actions taken to restore the Farm Credit Banks' financial soundness when agricultural conditions improve. Those issues are considered next.

Loan-Pricing Model

A loan-pricing model usually is specified so that loans are priced at levels that cover the

[1] As reported in the *Summary Report of Condition and Performance of the FCS* published by the Farm Credit Administration (FCA) on December 19, 1985, inconsistencies may arise in the quarterly reports of the FCA and the *Farm Credit Banks Quarterly Report to Investors*. For September 30, 1985, the latter report contains adjustments made by the funding corporation, acting as an agent for the thirty-seven banks, to reflect the accruals of known loan losses that had not been recorded by the individual banks nor reported as accrued losses to FCA. Thus, the FCA report indicates losses of $593 million for the Farm Credit Banks during the quarter ending September 30, 1985, while the funding corporation reports third quarter losses of $522.5 million.

[2] When this article was going to press, more recent financial reports from the Federal Credit Banks Funding Corporation indicated that the FCS experienced a combined net loss of $2.689 billion in 1985, an increase in the provision for loan losses to $2.969 billion, an allowance for loan losses of $3.190 billion at year end 1985, net charge-offs during 1985 of $1.105 billion, nonaccrual loans totaling $5.323 billion, other property owned of $928 million, and system-wide net loans totaling $66.6 billion. Those data include the financial position and results of operations for all units of the FCS (including PCAs and FLBAs) in contrast to the data only for the Farm Credit Banks as reported elsewhere in this article.

[3] The FCA quarterly report indicates that those nonaccrual loans are distributed as follows: FLBs, $3.3 billion; FICBs, $104.7 million; BCs, $129.9 million.

[4] The FCA quarterly report indicates that nonperforming loans for the thirty-seven banks totalled $10.611 billion and were distributed as follows: FLBs, $6.076 billion (57.3 percent); FICBs, $3.983 billion (37.5 percent); BCs, $0.552 billion (5.2 percent).

costs of administering and funding the loans as well as compensate for the risk and competitive positions of the various borrowers (Mason; Calvert and Barry). Administrative costs include the outlays for personnel, equipment, documents, rent, advertising, and so on that arise from acquiring and disbursing the funds. Funding costs include the interest payments on funds purchased in the financial markets and the desired return on the institution's equity capital. Costs of risk cover the possible delinquency and default by borrowers, unanticipated variations in the borrower's needs for funds, and the combined effects of other institutional risks and methods of responding to risk. "Costs" of competition are reflected by the conditions in the lending market; stronger (weaker) competition from other lenders generally results in lower (higher) prices and profits on loans. Finally, the loan price may reflect a "bundling" of costs and revenues from various services and activities that are closely related to the lending function (Mason).

The principal sources of funds for the Farm Credit Banks are from the sale of consolidated farm credit bonds and discount notes in the financial markets. Pricing at each bank has been based on the average cost of the bank's outstanding volume of those funds with loan rates to borrowers adjusted periodically as the average cost changes. A loan loss provision is allowed to cover anticipated losses and to build a contingent reserve against possible extraordinary losses in the future. The earnings rate reflects additions to capital surplus to account for potential loan growth and to accumulate equity above the levels attained by the required purchases of stock in the various FCS units by the system's borrowers.

Because the FCS is organized as a system of cooperatives, the true return on the equity invested by farm borrowers includes the value of the advantages in borrowing costs, credit availability, and other lending terms that arise from patronizing the FCS instead of other lenders. Thus, the earnings component of the interest rate charged to FCS borrowers differs from that on noncooperative commercial lenders due to the need to directly meet the profit requirements of the latter. Finally, the loan price also reflects the bundling effects of interest earned on investment securities held by the Farm Credit Banks as well as fees and other income earned on loan-related services.

Given those lending characteristics of the FCS, the loan-pricing model can be specified as

$$i = \frac{TE}{B} = \frac{I + L + O + E - S - F}{B}$$

That formulation depicts the loan rate charged to Farm Credit Bank borrowers as the interest rate (i) that must be charged on the outstanding loan balance (B) to ensure that sufficient revenue will be generated to cover the total expenses (TE) associated with the lending activity. Thus, the loan rate is found by dividing total expenses by the outstanding loan balance. Here, total expenses are broadly defined to include lending risks and any earnings resulting in additions to capital surplus. Thus, total expenses are the sum of interest costs (I) plus the provision for loan losses (L) plus other operating expenses (O) plus the earnings for building reserves (E) less the interest (S) earned on invested securities and service fees and other income (F).

In practice, some components of total expenses fluctuate within a time period so that the actual additions to reserves are greater or less than anticipated. In subsequent periods the loan rate can be adjusted up or down to compensate for those fluctuations. In addition, loan rates may be specified to float with changes in total loan expenses (changes in interest cost usually are the major source of repricing). Recently, however, the growth in loan losses has been a major cause of higher loan rates, even while interest costs have declined due to reductions in market rates of interest. Moreover, the decline in market rates has been countered for the Farm Credit Banks by higher premiums on Farm Credit securities relative to U.S. Treasury securities due to the system's stress. The higher losses and market premiums in turn have put upward pressure on loan rates to FCS borrowers.

Application to Loan Rates

That approach to loan pricing is

implemented by applying the model to the Farm Credit Banks in aggregate using data representative of 1985–86 conditions, except for the incidence of high loan losses which is considered later. In practice each of the thirty-seven Farm Credit Banks has a unique loan rate based on its own cost of funds, capital structure, operating costs, and other characteristics. Here, however, loan pricing is consolidated into an aggregate model in order to evaluate the general effects on Farm Credit Bank borrowers of alternative loss conditions and response methods. The aggregate approach is used since the various banks will share to some extent in the total losses experienced by the system. In addition, the measures of key pricing variables indicate relatively small differences among the FLBs, Federal Intermediate Credit Banks (FICBs), and Banks for Cooperatives (BCs). For example, the aggregate ratios of interest expenses to average total liabilities for 1984, expressed as a percentage, were 11.39 percent, 10.67 percent, and 10.79 percent for FLBs, FICBs, and BCs respectively; "other expenses" as a percent of average total loans were 0.54 percent, 0.57 percent, and 0.66 percent; and the aggregate debt-to-equity ratios at year end 1984 were 8.18, 8.69, and 7.65 for FLBs, FICBs, and BCs, respectively.[5]

The aggregate pricing approach also implies that loan losses will be distributed among the three types of farm credit banks according to their relative holdings of total loans. At year end 1984, the total loans (net of loss allowances) of the Farm Credit Banks were distributed as follows: 66.1 percent for FLBs, 22.4 percent for FICBs, and 11.5 percent for BCs. A different pattern of loan losses in the future would shift the higher loan rate to the Farm Credit Bank unit experiencing the higher proportion of losses. As shown in footnote three, the recently published FCA data show FICBs holding higher proportions of nonperforming loans to total loans and FLBs and BCs holding lower proportions. The absolute volume of troubled loans for FLBs has grown significantly as well. Of course, the rate differences within the banks comprising each of the three units also depend on each bank's loss experiences, leverage positions, and other characteristics.

The organizational approach in this analysis first specifies the numerical values on key pricing variables that will serve as a base. Then the pricing implications are considered for alternative loan loss levels and alternative length of adjustment periods for the bank's capital structure under two response methods: (a) repaying the financial assistance provided by the federal government, and (b) restoring the bank's depleted reserves without federal assistance. Finally, the pricing implications are considered for a selected loss level and several adjustment periods under different targets on the bank's aggregate leverage position.

Using the loan pricing worksheet in Table 4 and following the September 30, 1985, figures, the Farm Credit Banks are specified to have total outstanding debt obligations of $72 billion, loan volume of $71 billion, investment securities of $4.5 billion, and equity capital totaling $8.5 billion. The target debt-to-equity ratio thus is considered to be 8.47 ($72 billion of debt divided by $8.5 billion of equity). The average cost of funds for the bank's outstanding debt obligations is 10.5 percent, the addition to the loan loss provision is 0.5 percent of total loans, the interest rate on short-term securities is 8 percent, and the earnings rate is 5 percent of equity capital (equivalent to a 0.53 percent net return on total assets for the leverage position indicated above). Service fees and other income total $60 million. Given those specifications, the loan rate that is needed to cover all lending costs (net of earnings on securities and services) is 12.93 percent (Table 4).

The next step is to evaluate the effects on loan pricing of different levels of loan loss in which the federal government provides the financial assistance to cover the losses. Those effects are evaluated by determining the magnitude and duration of changes in the aggregate loan rate that would be needed to generate sufficient earnings to restore the target debt-to-equity ratio of 8.47, given the different levels of loan loss. For simplicity,

[5]Considerable variation in leverage ratios exists within the three types of banks. The FCA quarterly report for September 30, 1985, indicated debt-to-equity ratios for FLBs ranging from 7.0 for the Columbia Bank to 12.11 for the Omaha Bank; for FICBs, leverage ranged from 5.09 for the Louisville Bank to 12.46 for the Sacramento Bank; and for BCs, leverage ranged from 2.39 for the Jackson Bank to 12.30 for the Central Bank.

Table 4. Loan Pricing Worksheet

Item	Rate	Volume	Cost
Cost of Liabilities	0.105	72,000	7,560
Loan Loss Provision	0.015	71,000	1,065
Other Expenses			550
Earnings Rate	0.050	8,500	425
Less Int. on Sec.	0.080	4,500	360
Less Ser. Fee & Other Inc.			60
Loan Income			9,180
Loan Rate			0.1293

the loan losses are specified as net charge-offs and are assumed to occur immediately. Moreover, after surpassing the bank's allowance for loan losses ($1.089 billion on September 30, 1985, according to the *Report to Investors*), they directly reduce the outstanding loan volume and equity capital by the stipulated amounts. Thus a $4 billion loss beyond the allowance for loan losses would reduce the loan volume and equity capital to $67 billion and $4.5 billion, respectively. The banks then would need to accommodate additional earnings sufficient to restore the target leverage of 8.47.

As specified here, the earnings increment is used to repay federal assistance in the amount of the loan loss by making equally amortized annual loan payments for a stipulated length of loan (adjustment period) at an interest rate of 8.5 percent (that rate is comparable to the yield on intermediate- and long-term U.S. government securities in late 1985). For example, the annual amortized payment on a ten-year, $4 billion loan from the government to cover that level of loss is $609.6 million at an interest rate of 8.5 percent. That earnings increment is in addition to the earnings of $225 million occurring at the stipulated rate of 5 percent on the remaining equity capital of $4.5 billion. Other than those changes, the values of the other loan-pricing variables are assumed to remain constant.

The adjusted loan rates are shown in Table 5 for net losses ranging from $1 billion to $8 billion and for repayment periods ranging from one to twenty years with annual intervals between years one and five, and five-year intervals thereafter. To illustrate, consider again the $4 billion of losses and a ten-year repayment period in which to restore the target capital structure. As indicated above, the ten-year period of repaying $4 billion means an annual earnings increment of $609.6 million above the $225 million of earnings generated at the 5 percent rate on the $4.5 billion of equity capital. The resulting loan rate is 14.22 percent for the next ten years, after that the loan rate reverts to the base rate of 12.93 percent assuming all other variables remain constant. Thus, for those numerical specifications the loan rate during the adjustment period exceeds the base rate by 1.29 percentage points.

The adjusted rates for the $4 billion loss range from 19.79 percent for a one-year period to 13.94 percent for a twenty-year period. Those rates are 6.86 and 1.01 percentage points, respectively, above the base. Of course, the adjustment varies with the level of loan loss. For the ten-year period, the adjusted rate ranges from 13.24 percent for a $1 billion loss to 15.68 percent for an $8 billion loss. Adjusted rates for other loss levels and repayment periods are shown in Table 5.

The adjusted rates for restoring depleted bank reserves without the use of federal assistance are shown in Table 6. In that case the earnings increments resulting from the loan losses are based on sinking fund concepts. That is, the annual increments represent the uniform series of payments that must be invested each year at an interest rate of 8 percent (the assumed yield on short-term securities) in order to generate reserves sufficient to cover the respective loss levels by the end of the adjustment period. For example, the annual sinking fund payment over a ten-year period to recover $4 billion of losses is $276 million using the 8 percent interest rate. That increment is in addition to the $225 million of earnings generated each year at the 5 percent rate on the remaining

Table 5. Interest Rates for Alternative Loss Levels, Adjustment Periods, and Government Loan Repayment

Loss Level Bill. $	Adjustment Period							
	1	2	3	4	5	10	15	20
0	12.93	12.93	12.93	12.93	12.93	12.93	12.93	12.93
1	14.57	13.83	13.58	13.46	13.38	13.24	13.19	13.17
2	16.26	14.75	14.25	14.00	13.85	13.56	13.46	13.42
3	18.00	15.70	14.94	14.56	14.33	13.89	13.74	13.68
4	19.79	16.68	15.65	15.14	14.83	14.22	14.03	13.94
5	21.64	17.69	16.38	15.73	15.34	14.57	14.33	14.22
6	23.54	18.73	17.14	16.34	15.87	14.93	14.63	14.50
7	25.50	19.81	17.91	16.97	16.41	15.30	14.95	14.79
8	27.52	20.92	18.72	17.62	16.97	15.68	15.27	15.09

Table 6. Interest Rates for Alternative Loss Levels, Adjustment Periods, and Reserves Accumulation

Loss Level Bill. $	Adjustment Period							
	1	2	3	4	5	10	15	20
0	12.93	12.93	12.93	12.93	12.93	12.93	12.93	12.93
1	14.45	13.71	13.46	13.34	13.27	13.12	13.07	13.05
2	16.01	14.51	14.01	13.76	13.61	13.32	13.22	13.18
3	17.63	15.33	14.57	14.19	13.97	13.52	13.38	13.31
4	19.28	16.18	15.15	14.64	14.33	13.73	13.53	13.44
5	20.99	17.06	15.75	15.10	14.71	13.94	13.70	13.58
6	22.75	17.96	16.37	15.57	15.10	14.16	13.86	13.73
7	24.57	18.89	17.00	16.06	15.50	14.39	14.04	13.87
8	26.44	19.85	17.66	16.56	15.91	14.62	14.21	14.02

equity capital of $4.5 billion. As shown in Table 6, the adjusted loan rate is 13.73 percent for the next ten years, after which the rate reverts to the base figure of 12.93 percent.

The adjusted rate for accumulating reserves (13.73 percent) is lower than for repaying government assistance (14.22 percent) because of the different time points at which the obligations are based. In those specifications the repayment of the government loan occurs by amortizing the present value ($4 billion) of the obligation over the specified number of years with interest paid on the remaining balance. In contrast, the accumulation of reserves occurs by investing a series of payments at interest over the respective years in order to achieve a future value of $4 billion at the end of the period. Because the dollar values of the payments are lower in the latter case (even with the different interest rates on short-term reserves and the government loan), the resulting loan rates are lower as well.

As Table 6 shows, the adjusted rates for the $4 billion loss range from 19.28 percent for a one-year period to 13.44 percent for a twenty-year period. Those rates are 6.35 and 0.51 percentage points, respectively, above the base. Adjusted rates for other loss levels and adjustment periods are shown in the table.

The final step is to show the additional increases in the loan rate as a result of reducing the bank's target leverage to more conservative levels in order to maintain a greater safety margin in the bank's capital structure over the long term. Similar to the recovery from losses, a reduction in target leverage also comes from an increment to bank earnings that in turn will increase the interim loan rate to bank borrowers, as long as other variables remain constant. The adjusted rates for several leverage targets are shown in Table 7 for a $4 billion loss level under the different response methods and for three adjustment periods. The only difference from the loan rates in Tables 5 and 6 arises from the earnings increment needed to accumulate reserves sufficient to reduce the original debt-to-equity ratio of 8.47 to the revised targets of 8.0, 7.0, 6.0, and 5.0.

As occurred above, the earnings increment again is calculated using sinking fund concepts. To illustrate, the revised leverage target of 6.0 means that $12 billion of equity capital is needed to support the $72 billion of outstanding debt obligations. Thus, $3.5 billion of equity is needed in addition to the original level of $8.5 billion. For a ten-year adjustment period and the 8 percent interest rate on reserves, an annual sinking fund payment of $241.6 million is needed to attain a future equity value of $3.5 billion at the end of year ten. Adding this increment to the amortized payment on the government loan and resolving the loan-pricing model yields an adjusted loan rate of 14.58 percent. That rate is 0.36 percentage points above the rate of 14.22 percent (Table 5) needed to recover from the $4 billion loan loss and 1.65 percentage points above the base rate of 12.93 percent. When no government assistance occurs, the same procedures yield an adjusted rate of 14.09 percent for ten years in order to accumulate reserves sufficient to cover the loan loss and achieve a target leverage of 6.0. As Table 7 shows, the adjusted rates are lower for longer adjustment periods and for higher targets on leverage.

Implications and Concluding Comments

This article sought to develop a simple, yet effective way for borrowers from the Farm Credit Banks to consider longer term cost consequences that result from mounting loan losses and continuing financial problems in agriculture. As indicated in the introduction most of the public debate has focused on the banks' vulnerability to financial stress and on establishing an initial program of financial assistance. Little attention has been given to the future cost implications of eventual efforts by the Farm Credit Banks to restore their financial soundness and to repay any government assistance. Unless such assistance is a gift, the capital needed to restore financial soundness and to meet the repayment obligation must come from future borrowers who own and patronize the Farm Credit Banks. The consequences will be higher loan rates for those borrowers than would otherwise occur and adverse effects on the banks' competitiveness in the agricultural credit markets. Moreover, the borrowing costs for farmers and other agricultural borrowers of FCS will be higher still due to the markup in rates as loan funds are channeled through PCAs and FLBAs.

The magnitude and duration of higher loan rates for borrowers will depend on the level of loan loss, the length of the adjustment period, the earnings rate on short-term reserves, the degree of subsidy in the government's financial assistance, and other changes in the Farm Credit Banks' operating environment. Clearly, the greater the loan loss, the greater will be the cost effect on the banks' borrowers. However, lengthening the adjustment period will distribute the burden over time and thus ease the near-term cost pressures. For example, the numerical results of the loan-pricing model for the case with a government loan and subsequent repayment indicate that an adjustment period of at least ten years would keep the increment to loan rates under 1.5 percent for losses up to about $4 billion. Similar relationships can be established for other loss levels and adjustment periods as well as for accumulating reserves without federal assistance.

A higher level of subsidy in the assistance program would transfer more of the cost burden from the Farm Credit Banks' borrowers to the public sector. For example, the numerical analysis assumed that interest

Table 7. Interest Rates for Alternative Leverage Targets for a $4 Billion Loan Loss and Different Adjustment Periods and Response Methods

Debt-to-Equity Ratio	Repay Federal Assistance			Accumulate Reserves		
	5 years	10 years	20 years	5 years	10 years	20 years
8.47 (base)	14.83	14.22	13.94	14.33	13.73	13.44
8.00	14.96	14.27	13.96	14.46	13.78	13.46
7.00	15.28	14.42	14.00	14.79	13.91	13.50
6.00	15.72	14.58	14.06	15.22	14.09	13.56
5.00	16.33	14.83	14.14	15.83	14.33	13.64

was charged at the rate of the government's cost-of funds. Lower rates would reduce the total obligation and allow shorter adjustment periods. In addition various levels of principal write-down or loan forgiveness by the government would also reduce the obligation and shorten the adjustment period. However, the Farm Credit Banks likely will seek to repay most or all of any federal assistance. That is consistent with the behavior of other recent recipients of federal assistance (e.g., Chrysler Corporation) as well as with the Farm Credit System's repayment of the government capital that was originally allocated to create the system.

Other effects on future loan rates will depend on changes in other loan-pricing variables. An improvement in farm income and the related growth in loan demand would reduce the increment to loan rates by spreading it over a larger loan volume and thus ease the adjustment burden. Perhaps broader lending authorities for the FCS might have a similar effect. As indicated in the numerical analysis, a change in the target leverage ratio would also affect the earnings increment, although it is more likely that leverage will decline rather than increase, thus putting more upward pressure on loan rates. The distribution of those adjustments among the Farm Credit Banks will depend on their own loss experiences, leverage, and other operating characteristics. Heavier adjustments are anticipated for the FLBs and FICBs due to their potentially large loss conditions.

Another adverse effect involves the cost of funds from the sale of farm credit securities in the financial markets. The increment to loan rates during the adjustment period will be higher still if the interest rates on farm credit bonds and discount notes increase to reflect their higher risks. Indeed, the yield spread between the farm credit securities and U.S. Treasury securities widened considerably in the second half of 1985 as the financial problems of the FCS were being disclosed; it is unlikely that the spread will return to its prestress levels, at least until the financial problems of the FCS are fully resolved.

Finally, the competitive implications for the agricultural credit markets depend on the financial conditions of other types of lenders. Agricultural banks, for example, are also experiencing financial problems in agricultural lending (Melichar and Irwin). They, too, have adjusted their pricing policies to pass part of those costs along to borrowers, although the greater diversity of their loan portfolios and other assets gives commercial banks greater flexibility in responding to financial adversities. All of those factors will influence the future competitive position of the FCS. They will also affect policy deliberations about the system's mission as a specialized agricultural lender with unique regulatory exemptions and preferences in its funding activities (Lins and Barry). Maintaining those unique features may be necessary to ensure a reliable source of funds to sustain the system's mission as a reliable lender to agriculture during a lengthy adjustment period.

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An Evaluation of Alternative Loan Volume Forecasting Models for a Federal Intermediate Credit Bank

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Abstract

The performance of two, single-equation econometric models, a univariate Box-Jenkins model, and two composite models for forecasting Sixth District Federal Intermediate Credit Bank (Bank) monthly loan volume outstanding are compared with an averaging model now in use by the Bank. Senior Bank officers desire both accurate point forecasts and turning point identification. Results suggest that for predictive accuracy the monthly dummy variable econometric model or either composite model are preferred to the averaging model used by the Bank. When turning point predictions are the primary objective, the averaging model performs best.

Key words: forecasting, loan volume, econometric, ARIMA, composite.

There is a keen interest in and a resource commitment to generating forecasts of agricultural time series, particularly prices (e.g., Bessler and Brandt; Brandt and Bessler; Harris and Leuthold; Just and Rausser; Kulshreshtha, et al.). Many business forecasters use simple extrapolative models, but academic forecasters seem to prefer statistical forecasting techniques such as econometric or time series analysis. The demand for agricultural forecasts does not solely lie in the realm of agricultural commodity prices, however. For instance, being able to predict future levels of debt can be useful to institutions involved in providing operating and nonreal estate credit to farmers and agribusinesses. One such institution is the St. Louis Federal Intermediate Credit Bank (Bank). The Bank serves the Farm Credit System's Sixth District —Illinois, Missouri, and Arkansas.

This study compares the performance of five forecasting models used to predict changes in Sixth District FICB outstanding nonreal estate loan volume with the performance of an averaging model currently used by the Bank. In addition to the Bank's model, the five forecasting models examined are: two, single-equation econometric models; one univariate Box-Jenkins or ARIMA model; and two composite forecast models.

A survey conducted by Farmbank Research Service (FRS) to ascertain the specific needs of Bank officers for projections of loan volume indicated that the officers would benefit from point forecasts and turning point predictions of monthly loan volume for at least a twelve-month planning horizon. Given those needs, forecast performance among the six models was judged by comparing predicted with actual monthly outstanding loan volume using the following criteria:

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absolute and average absolute error, mean square percentage error, and a measure of directional accuracy, (i.e., turning point identification and trend prediction). Based on those comparisons, recommendations are made with respect to which of the six models may best serve the various forecasting needs of Bank management.

Forecasting regional loan volume outstanding has received little attention, although econometric analysis of the U.S. demand for farm loans has been done by several agricultural economists (Herr, 1967 and 1975; Lins; Njinkeu). In the literature reviewed, only the study conducted by FRS for the Bank analyzed alternative regional loan volume forecasting models. That research examined three techniques for forecasting monthly loan volume in the Sixth District: single and multiple variable autoregressive integrated moving average (ARIMA and MARIMA, respectively) and an averaging technique. Regression methods were not analyzed. Statistics used to measure forecast performance were average absolute error, variance of forecast, and incorrect turning point accuracy. The model that exhibited the best ability to project gross Bank loans outstanding for monthly intervals was the averaging model, which calculated average monthly changes in loan volume over time. The averaging model also tracked turning points better than the ARIMA models. A conclusion drawn from the FRS study was that a series of forecasts averaged together over time produced a combined forecast that was superior, in accuracy and stability, to any one forecast by itself.[1]

Forecasting Models

Our objective is to develop forecasting models that will predict changes in outstanding nonreal estate loan volume, and that are relatively accurate and simple to understand, use, and update, and are theoretically sound. Because our major purpose is forecasting, we provide only minimal discussion of the variables used in the econometric model. Data used throughout the research were compiled by the Economic Research Service (USDA) or provided by the Bank.

Equations 1 and 2 are loan volume dependent, monthly demand models.[2] Equation 1 is a serially corrected regression equation with current observations. Using generalized least squares (GLS) regression over the eighty-four-month period from January 1976 through December 1982 results are:

Econometric (ECON)

$$
\begin{aligned}
LVO_t = {} & -48.24 \quad -.32CR_t \quad -.009FLB_t \quad +85.71FCR_t \\
& (-1.77)^{**} \quad (-2.40)^{*} \quad (-2.80)^{*} \quad (5.54)^{*} \\
& -30.93JAN_t \quad -5.40FEB_t \quad +37.58MAR_t \quad +39.89APR_t \\
& (-2.73)^{*} \quad (-.520) \quad (3.57)^{*} \quad (3.65)^{*} \\
& +47.34MAY_t \quad +74.85JUN_t \quad +58.25JUL_t \quad +51.48AUG_t \\
& (4.27)^{*} \quad (6.87)^{*} \quad (5.37)^{*} \quad (4.64)^{*} \\
& +40.41SEP_t \quad -24.65OCT_t \quad -43.74NOV_t \\
& (3.75)^{*} \quad (-1.87)^{**} \quad (-4.21)^{*}
\end{aligned}
\tag{1}
$$

*significant at the 5 percent level
**significant at the 10 percent level

where $R^2 = .89$, $F = 32.42$, and Durbin Watson = 1.97. LVO is the monthly change in loan volume outstanding measured in millions of nominal dollars. Its value is the change in loans outstanding from the beginning of the month to the end of the month. The regressor set is comprised of cash receipts from farm marketings in the Sixth District (CR), refinancings from the

[1]An example of a combined forecast as defined by FRS follows: Suppose a forecast made in July 1984 predicts that loan volume will be $1.1 billion on January 1, 1985, and another forecast produced in October predicts that January loan volume will be $900 million. The combined forecast for January 1, 1985, would be $1 billion.

[2]A study by Njinkeu evaluated the theoretical, statistical, and in-sample forecasting properties of ten analytical models—one ARIMA and nine econometric—in order to determine which models were best with respect to predictive ability. Equations 1, 2, and 3 are drawn from his research. Model 1 (Equation 1) exhibited the lowest forecast error and had the second lowest number of turning point errors over the time period analyzed. Model 2 (Equation 2) is included here because it was the only econometric model analyzed that was capable of generating ex ante forecasts without the need to first forecast current exogenous variable values before predicting the dependent variable—an important consideration for any serious forecaster constrained by time and funds. Although it did not perform best based on forecast accuracy or ability to predict turning points, Model 2 did exhibit acceptable statistical properties.

Sixth District Federal Land Bank (FLB), the prime interest rate at commercial banks relative to the cost of funds from the Sixth District FICB (FCR), and monthly seasonal dummy variables, JAN, . . . , NOV. The variables CR and FLB are expressed in millions of dollars. We surmised that as CR and FLB increased, the need for loans from the bank would decrease; hence, their hypothesized signs are negative. FCR is the ratio of the average monthly commercial bank prime interest rate to the average monthly interest rate charged by the Sixth District FICB. Relative cost of funds is hypothesized to be positively related to change in loans outstanding. The introduction of a time component is made because of the seasonality that dominates Sixth District farming activities. It is hypothesized that a dummy variable's coefficient is negative during harvest and immediately thereafter because that is when farmers traditionally pay their debt. On the other hand we hypothesized that the dummy variable coefficients would be positive during the spring and summer months because that is when farmers borrow for seasonal needs. One might also hypothesize that February and September are transition months with some farmers taking out new loans while others are paying their loans. Therefore, the signs on February and September would be indeterminate and likely to have low t values. The t values in parentheses indicate that the relationships of the explanatory variables to change in loan volume outstanding are reliable at the 5 or 10 percent significance level except for the February dummy variable. The signs are as expected.

Equation 2 is a serially corrected regression equation that expresses monthly change in loan volume outstanding as a function of the monthly dummy variables only. Again, the period of fit is January 1976 through December 1982. Using a GLS estimator, the estimated model is:

Econometric Dummy (ECOND)

$$\begin{array}{llll} -1.94 & -43.39\text{JAN} & -11.85\text{FEB} & +29.37\text{MAR} \\ (.22) & (-4.79)^{*} & (-1.09) & (2.53)^{*} \\ \\ +33.15\text{APR} & +36.50\text{MAY} & +19.72\text{JUN} & +34.74\text{JUL} \\ (2.77)^{*} & (3.01)^{*} & (1.07)^{*} & (2.87)^{*} \\ \\ +31.55\text{AUG} & +17.22\text{SEP} & -58.33\text{OCT} & -65.34\text{NOV} \\ (2.64)^{*} & (1.49) & (-5.47)^{*} & (-7.52)^{*} \end{array} \quad (2)$$

$R^2 = .75$, $F = 13.65$, and $DW = 2.01$. T values indicate that all coefficient values are significant at the 5 percent level except February and September. Signs are as anticipated.

An alternative forecasting technique is Box-Jenkins univariate time series analysis. It takes into account past behavior of the time series and current and past errors.

Using the methods of Box and Jenkins, the following purely autoregressive ARIMA model (i.e., MA = 0) was specified for monthly change in loan volume outstanding.

ARIMA

$$\underset{(-2.15)}{(1 + .36B^{12})}(1 - B)(1 - B^{12})\text{LVO}_t = a_t \quad (3)$$

where B is the backward operator ($\text{BLVO}_t = \text{LVO}_{t-1}$) and a_t is a random disturbance. The model was estimated over the period January 1976 to December 1982. The chi square statistic associated with the estimated residuals was under the critical value at the 5 percent level of significance as is the t ratio associated with the autoregressive component.

Forecasters and managers often want to determine which particular prediction method or model is best for selected performance criteria. In that regard one model may be chosen and the others discarded. Very often the discarded models contain information not included in the "best" forecast model. Bates and Granger have suggested that a composite method is often preferred to forecasts given by individual models. Researchers (Bessler and Brandt), using empirical data, have demonstrated that composite forecasts are likely to outperform forecasts from individual models.

In this study two composite models that combine the forecasts of Equations 1, 2, and 3 are considered. The equations are combined to predict monthly change in loan volume outstanding. Equation 4 is the

*significant at the 5 percent level

composite of equally weighted Equation 1 and Equation 3 forecasts such that

Composite I (ECON-ARIMA)

$$LVO_t = (LVO_{ECON,t} + LVO_{ARIMA,t})/2. \quad (4)$$

while Equation 5 is the composite of Equations 2 and 3 whereby

Composite II (ECOND-ARIMA)

$$LVO_t = (LVO_{ECOND,t} + LVO_{ARIMA,t})/2. \quad (5)$$

Equal weights are chosen because not enough information is available on the historical performance of each model.

An averaging (AVG) model is currently used by the FICB to forecast monthly loan volume; its predictive ability is compared to the forecast performance of the models mentioned above. That model uses a historical data series of the average percentage change in loans outstanding for monthly data from 1973 to the current month to project monthly loans outstanding. Forecasts are generated in the following manner: a twelve-month forecast is made each month; that is, each month a forecast is made for end-of-month loan volume outstanding for each of the next twelve months. Multiplying the historical average percentage change in loans outstanding between the prior month and the forecast month by the prior month's actual loans outstanding and by adding that value to the prior month's actual loans outstanding, the first month forecast is determined. The two-to-twelve-month forecasts are generated in a similar manner. All calculations are based on end-of-month values.

Average Model (AVG)

$$LVOL_t = LVOL_{t-1} + a_t(LVOL_{t-1}) \quad (6)$$

where $LVOL_t$ is the level of loan volume outstanding for the current month, $LVOL_{t-1}$ is the level of loan volume outstanding for the month preceding the current month, and a_t is the average percentage change in loans outstanding for the prior and current month from 1973 to the current period.

Forecast Results and Evaluation

After initially estimating and examining the statistical fit of each alternative forecasting model, forecasts for Sixth District loans outstanding are generated. Then, performance measures of each model's forecasting ability are computed and compared among forecast models. More specifically, Equations 1 through 5 predict monthly change in loans outstanding. That change is then added to or subtracted from the preceding month's volume of loans outstanding to yield a forecast of end-of-month loans outstanding. Note that the bank's averaging model directly forecasts the level of monthly loans outstanding. In total, a dozen twelve-month ex post forecasts are generated for each model. Therefore, the particular performance measures used here indicate how well each model predicts over a period of twenty-three months: January 1983 through November 1984.

The first twelve-month ex post forecast sequence covers the period January 1983 to December 1983. Upon addition of new monthly data, each forecasting model is reestimated and a new, updated twelve-month forecast series is generated. As new monthly data are added, the oldest monthly data are dropped. In that manner, the number of months over which a model is estimated remains constant. Therefore, the second twelve-month ex post forecast sequence (February 1983 through January 1984) results from models that are estimated over the eighty-four-month period February 1976 through January 1983. Similar procedures are followed until the last twelve-month forecast series is made (December 1983 to November 1984). Econometric models are reestimated and the ARIMA model is reidentified each time a new forecast series is generated.[3]

Forecast results, reported as percent difference between actual and forecasted values, and associated summary statistics for Sixth District FICB loans outstanding are presented in Tables 1 through 6.[4] Loan

[3]Space limitations prohibit reporting the estimated updated models; the coefficient values of the econometic models differ only slightly from those reported in Equations 1 and 2. A frequently used, updated ARIMA model was of the form $(1 + \phi_1 B + \phi_5 B^5)(1 - B)(1 - B^{12})LVO_t = a_t$.

[4]Actual and forecasted loan volumes outstanding are available upon request.

volumes are end-of-month values expressed in nominal dollars.

Mean square percentage error (MSPE) comparisons among models for each twelve-month forecast do not give a clear picture of model performance. Therefore, to facilitate comparisons, average MSPEs are computed for all forecast models. Those results indicate that the two composite models (Equations 4 and 5) perform equally well and better than the other models over the entire forecast horizon. The ECOND model (Equation 2) performs third best, while the ECON (Equation 1), ARIMA (Equation 3), and AVG (Equation 6) models perform fourth, fifth, and last, respectively.

Examination of average absolute errors in Tables 1 through 6 indicates that the Bank's AVG model (Equation 6) is the only one that exhibits increasing forecast error over the entire twelve-month forecast horizon. The AVG model's projections are on average accurate to within 7.1 percent six months out and 10.5 percent a year out. Three of the five alternative models—ECOND (Equation 2), ECOND-ARIMA (Equation 5), and ECON-ARIMA (Equation 4)—show an average absolute error twelve-months ahead that is no greater than, if not less than, the one-month ahead average absolute error. At no time do the two econometric and two composite models have an average absolute error greater than 4 percent.

Table 1. Summary of Statistics for Monthly Forecasts of Sixth District FICB Outstanding Nonreal Estate Loan Volume by ECON Model (Equation 1)

Time Horizon (Months Ahead)[a]	Month Forecast Begins (1983)[b]												Average Absolute Error[d]
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	percent difference between actual and forecasted values[c]												
1	.091	.044	.010	-.007	-.014	-.009	-.021	-.018	-.007	-.007	.073	.033	.028
2	.045	.009	-.002	-.015	-.007	-.018	-.017	-.007	.062	.064	.030	.078	.030
3	.012	-.004	-.011	-.011	-.017	-.016	-.006	.061	.073	.073	.074	.036	.033
4	-.003	-.013	-.008	-.019	-.014	-.005	.062	.073	.029	.031	.032	-.002	.024
5	-.012	-.010	-.016	-.017	-.004	.063	.073	.029	.073	.074	-.006	-.017	.033
6	-.010	-.018	-.014	-.006	.063	.072	.030	.073	.031	.031	-.021	-.018	.032
7	-.017	-.015	-.003	.061	.074	.030	.074	.030	-.007	-.007	-.023	-.046	.032
8	-.014	-.005	-.064	.071	.032	.073	.031	-.008	-.022	-.021	-.048	-.022	.034
9	-.003	.063	.075	.029	.075	.030	-.077	-.023	-.024	-.023	-.027	-.020	.039
10	-.064	.074	.033	.072	.032	-.007	-.022	-.025	-.049	-.047	-.025	-.008	.038
11	.075	.032	.076	.029	-.005	-.022	-.024	-.050	-.028	-.027	-.012	.054	.036
12	.033	.075	.033	-.008	-.021	-.022	-.049	-.028	-.026	-.025	.051	.079	.038
													Average MSPE[f]
MSPE[e]	.002	.002	.002	.001	.002	.002	.002	.002	.002	.002	.002	.002	.002

[a]The forecast time horizon indicates the number of months projected into the future from the starting date.

[b]The origination date of the forecast. For example, JAN relates to the ex post forecast sequence that begins January 1983 and ends December 1983. In a similar manner, FEB begins February 1983 and ends January 1984, and DEC begins December 1983 and ends November 1984.

[c]The numbers in the body of the table indicate the percentage difference between actual and forecasted values for the forecast time horizon shown. Actual values are used as the base for calculating percentage differences.

[d]Average absolute errors are calculated for each time horizon by adding the absolute values of each error in the row and averaging them.

[e]Mean square percentage error

$$MSPE = \frac{1}{T} \sum_{t=1}^{T} \left(\frac{F_t - A_t}{A_t} \right)^2$$

where F = forecasted loan volume outstanding time period t,
A = actual loan volume outstanding time period t,
T = number of months simulated (12).

[f]Average MSPE of the twelve forecast sequences.

Table 2. Summary Statistics for Monthly Forecasts of Sixth District FICB Outstanding Nonreal Estate Loan Volume by ECOND Model (Equation 2)

Time Horizon (Months Ahead)[1]	Month Forecast Begins (1983)[2]												Average Absolute Error[3]
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	percent difference between actual and forecasted values[4]												
1	.035	.011	-.026	-.029	-.032	-.040	-.029	.071	-.014	-.014	.073	.002	.031
2	.008	-.026	-.029	-.031	-.042	-.028	-.026	.025	.046	.049	.030	.052	.033
3	-.027	-.029	-.032	-.041	-.029	-.025	-.014	.018	.058	.003	.074	.011	.030
4	-.030	-.032	-.041	-.028	-.026	-.014	.046	.036	.003	.003	.032	-.027	.027
5	-.033	-.042	-.029	-.025	-.014	.047	.056	-.016	.053	.053	-.006	-.032	.034
6	-.042	-.029	-.025	.014	.046	.056	.003	.052	.012	.012	-.021	-.032	.029
7	-.029	-.026	-.014	.047	.056	.003	.053	.012	-.026	-.025	-.023	-.047	.030
8	-.026	-.015	.047	.056	.003	.053	.012	-.025	-.031	-.030	-.048	-.029	.031
9	-.015	.045	.055	.003	.053	.012	-.025	-.031	-.032	-.030	-.027	-.026	.030
10	.045	.052	.002	.053	.012	-.025	-.030	-.031	-.045	-.044	-.025	-.013	.031
11	.053	.003	.052	.011	-.026	-.031	-.029	-.045	-.028	-.028	-.012	.047	.030
12	-.002	.042	.010	-.026	-.031	-.030	-.041	-.027	-.025	-.025	.051	.054	.030
													Average MSPE[5]
MSPE[5]	.001	.001	.001	.001	.001	.004	.001	.001	.001	.002	.001	.001	.0013

[1] See Table 1.

Table 3. Summary Statistics for Monthly Forecasts of Sixth District FICB Outstanding Nonreal Estate Loan Volume by ARIMA Model (Equation 3)

Time Horizon (Months Ahead)[1]	Month Forecast Begins (1983)[2]												Average Absolute Error[3]
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	percent difference between actual and forecasted values[4]												
1	.025	-.008	-.074	-.067	-.012	.106	.071	.047	-.016	-.014	.073	-.006	.043
2	-.014	-.059	-.023	-.043	.003	.171	.111	.010	-.006	-.048	.030	.016	.053
3	-.064	-.047	-.067	-.025	.073	.122	.049	-.006	-.038	-.023	.074	-.059	.054
4	-.052	-.047	-.042	-.009	.090	.152	.017	.004	-.010	-.027	.032	-.012	.041
5	-.052	-.087	-.025	.041	.057	.116	-.004	-.029	-.021	-.007	-.006	-.076	.043
6	-.091	-.051	-.010	.063	.088	.070	.007	-.004	.012	-.070	-.021	-.115	.044
7	-.060	-.046	.039	.032	.049	.061	-.026	.012	.085	.133	-.023	-.125	.058
8	-.053	.033	.066	.063	-.005	.075	.002	.029	.157	.055	-.048	-.110	.058
9	-.040	.015	.032	.019	.001	-.063	.017	.104	.069	.093	-.027	-.137	.051
10	-.008	.034	.062	-.030	.015	-.028	.042	.165	.115	.031	-.025	-.113	.056
11	.026	-.014	.020	-.004	-.045	-.015	.114	.084	.044	-.005	-.012	-.119	.042
12	-.022	.021	.003	.026	-.009	.012	.172	.120	.011	-.020	.051	-.111	.048
													Average MSPE[5]
MSPE[5]	.002	.002	.002	.002	.004	.004	.005	.005	.004	.005	.009	.009	.0040

[1] See Table 1.

Table 4. Summary Statistics for Monthly Forecasts of Sixth District FICB Outstanding Nonreal Estate Loan Volume by Composite Model I—ECON and ARIMA (Equation 4)

Time Horizon (Months Ahead)[a]	Month Forecast Begins (1983)[c]												Average Absolute Error[d]
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	percent difference between actual and forecasted values[b]												
1	.058	.001	-.008	-.037	-.022	.048	.025	.015	-.015	-.014	.021	-.002	.022
2	.016	-.042	-.013	-.029	-.019	.077	.047	.002	.022	.001	.008	.034	.026
3	-.026	-.038	-.039	-.017	-.021	.053	.021	.028	.011	.017	.065	-.024	.030
4	-.027	-.039	-.025	-.014	-.032	.073	.039	.038	.002	-.012	.076	-.020	.033
5	-.032	-.064	-.021	-.012	.073	.089	.035	.000	.022	.023	.018	-.054	.037
6	-.050	-.040	-.012	.029	.067	.071	.018	.034	.009	.041	.033	-.074	.040
7	-.038	-.036	.018	.046	.052	.046	.024	.004	.028	.054	-.001	-.085	.036
8	-.034	-.024	.065	.067	-.001	.074	.017	.025	.053	.013	-.033	-.069	.040
9	-.022	.030	-.014	.024	.027	.012	.005	.047	.013	.031	-.030	-.081	.028
10	.036	.046	.048	.021	.069	-.025	.010	-.046	.020	-.030	-.024	-.063	.037
11	.051	-.008	-.018	.017	.038	-.031	.045	.011	-.006	-.016	-.033	-.036	.023
12	.005	.031	.042	.009	.011	-.030	.062	.000	-.017	-.023	.010	-.028	.022
MSPE[e]	.001	.001	.001	.001	.002	.001	.001	.001	.000	.001	.001	.003	Average MSPE[f] .0010

[a] [b] [c] [d] [e] [f] See table 1

Table 5. Summary Statistics for Monthly Forecasts of Sixth District FICB Outstanding Nonreal Estate Loan Volume by Composite Model II—ECOND and ARIMA (Equation 5)

Time Horizon (Months Ahead)[a]	Month Forecast Begins (1983)[c]												Average Absolute Error[d]
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	percent difference between actual and forecasted values[b]												
1	.059	.001	-.026	-.048	-.022	.032	.020	.011	-.019	-.014	.012	-.002	.022
2	.028	-.042	-.026	-.037	-.019	.072	.043	-.002	.015	.001	-.005	.034	.027
3	-.016	-.038	-.049	-.033	.022	.049	.017	.021	.002	.017	.054	-.019	.028
4	-.012	-.039	-.042	-.019	.032	.069	.032	.030	-.011	-.012	.071	-.020	.032
5	-.013	-.064	-.027	.008	.022	.081	.025	-.055	.011	.028	.008	-.054	.033
6	-.039	-.040	-.018	.025	.067	.063	.005	.024	.004	.041	.028	-.074	.036
7	-.015	-.036	.012	.039	.052	.032	.014	.016	.019	.054	-.005	-.085	.032
8	-.007	-.024	.056	.059	-.001	.064	.098	.002	.048	.013	-.032	-.069	.039
9	.004	.030	.044	.011	.027	-.021	-.010	.037	.009	.031	-.031	-.081	.028
10	.071	.043	.032	.011	-.062	-.027	.016	.067	.022	-.006	-.025	-.063	.037
11	.109	-.008	.036	.012	-.035	-.023	.005	.020	-.001	-.016	-.034	-.036	.028
12	.032	.031	-.002	.000	-.020	-.009	.021	.046	-.017	-.023	.007	-.028	.020
MSPE[e]	.002	.001	.001	.001	.001	.000	.001	.001	.000	.000	.001	.003	Average MSPE[f] .0010

[a] [b] [c] [d] [e] [f] See Table 1.

Table 6. Summary Statistics for Monthly Forecasts of Sixth District FICB Outstanding Nonreal Estate Loan Volume by AVG Model (Equation 6)

Time Horizon (Months Ahead)[1]	Month Forecast Begins (1983)[2]												Average Absolute Error[3]
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	percent difference between actual and forecasted values[4]												
1	-.060	-.036	-.035	-.012	-.024	.000	-.010	-.003	-.013	-.011	.002	.008	.018
2	-.098	-.072	-.047	-.036	-.024	-.010	-.012	-.016	-.024	-.009	.010	-.015	.031
3	-.136	-.085	-.072	-.036	-.034	-.012	-.026	-.027	-.022	.000	-.012	-.018	.040
4	-.150	-.111	-.072	-.046	-.037	-.026	-.037	-.025	-.014	-.023	-.016	-.047	.050
5	-.177	-.111	-.082	-.049	-.050	-.037	-.034	-.016	-.037	-.027	-.045	-.068	.061
6	-.177	-.121	-.085	-.063	-.062	-.034	-.026	-.040	-.040	-.057	-.066	-.081	.071
7	-.189	-.124	-.100	-.074	-.059	-.026	-.050	-.043	-.070	-.077	-.078	-.060	.079
8	-.192	-.139	-.112	-.072	-.051	-.049	-.053	-.073	-.092	-.090	-.058	-.040	.085
9	-.207	-.151	-.109	-.063	-.075	-.053	-.083	-.094	-.105	-.069	-.038	-.031	.090
10	-.220	-.149	-.100	-.087	-.078	-.083	-.105	-.107	-.084	-.049	-.029	-.042	.094
11	-.218	-.139	-.125	-.091	-.109	-.105	-.118	-.086	-.063	-.040	-.039	-.040	.098
12	-.208	-.166	-.129	-.122	-.131	-.118	-.097	-.066	-.054	-.051	-.038	-.077	.105
MSPE[5]	.031	.015	.009	.005	.005	.003	.004	.004	.004	.003	.002	.003	Average MSPE[6] .007

[1] See Table 1

Forecasting performance with respect to directional accuracy is summarized in Table 7, that is, the ability of the forecast models to anticipate turning points and trends. A turning point (change in direction) occurs if actual loan volume increases one month, then decreases the next (a peak), or if actual loan volume decreases one month, then increases the next (a trough). An up trend occurs when loan volume increases for two or more consecutive months, while a down trend occurs when volume decreases for two or more months in a row.

Each forecast model's accuracy in predicting points and trends is determined for each twelve-month forecast. To aid comparison among models, total correct and incorrect turning point forecasts and correct and incorrect trend forecasts are computed for each model and then reported as total correct predictions (correct turn and trend forecast) as a percentage of total correct plus total incorrect predictions (correct turn and trend forecast plus incorrect turn and trend forecast).[5] Consequently, at a maximum, correct turn and trend movement can be forecast eleven times within a twelve-month forecast interval or 132 times over all twelve, twelve-month forecast sequences.

Examination of Table 7 reveals that the AVG model predicts turning points and trends exceptionally well and better than all other models. The ECOND, ECON-ARIMA composite, and ECON models perform nearly equally, while the ECOND-ARIMA composite and ARIMA models are the poorest predictors. These latter five models are able to correctly predict 47 to 60 percent of all turning points and trends compared to 99 percent correct prediction for the AVG model.

[5] A correct turn forecast occurs when forecasted and actual loan volume increases one month, then decreases the next or decreases one month, then increases the next. A correct trend forecast is made when forecasted and actual loan volume move in the same direction two or more months in a row. Each observed turn and trend in loan volume that is correctly forecast adds an increment to total correct. An incorrect turn forecast occurs when forecasted loan volume indicates a peak or trough while actual loan volume shows no turn. An incorrect turn forecast may also occur when forecasted loan volume indicates a peak turn while actual loan volume shows a trough; and conversely when forecasted loan volume indicates a trough when, in fact, actual loan volume peaks. An incorrect trend forecast occurs when forecasted directional movement of loan volume is opposite the actual direction of trend. Each incorrectly forecast turn and trend in loan volume adds an increment to total incorrect.

Table 7. Turning Point and Trend Errors for Evaluating Directional Accuracy of Sixth District FICB Outstanding Nonreal Estate Loan Volume Forecasts by Model Type

Turn and Trend Forecasts by Model[a]	Month Forecast Begins (1983)[b]												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total[c]
ECON													
CTF[d]	0	0	0	0	0	0	0	0	0	1	0	0	1
ITF[e]	2	3	4	4	4	4	4	3	3	0	3	2	36
CDF[f]	6	6	5	5	5	5	5	6	7	10	6	7	73
IDF[g]	3	2	2	2	2	2	2	2	1	0	2	2	22
% Correct[h]													56%
ECOND													
CTF	1	1	0	0	0	0	0	1	0	1	0	0	4
ITF	2	2	4	4	4	4	4	3	3	0	3	2	35
CDF	6	8	5	5	5	5	5	6	7	10	6	7	75
IDF	2	0	2	2	2	2	2	1	1	0	2	2	18
% Correct													60%
ARIMA[i]													
CTF	0	0	0	0	1	0	1	1	0	0	0	0	3
ITF	4	5	2	4	6	8	1	3	1	1	3	4	42
CDF	3	3	7	4	2	1	5	5	9	9	6	6	60
IDF	4	3	2	3	2	2	4	2	1	1	2	1	27
% Correct													47%
COMPI. ECON-ARIMA[j]													
CTF	0	0	0	1	2	0	1	1	0	0	2	0	7
ITF	2	5	4	3	4	5	5	5	5	1	1	2	42
CDF	6	5	5	5	5	5	4	4	5	10	8	7	69
IDF	3	1	2	2	0	1	1	1	1	0	0	2	14
% Correct													58%
COMPII. ECOND-ARIMA[k]													
CTF	1	0	0	1	1	0	1	1	0	0	2	0	7
ITF	4	5	4	3	6	5	5	5	5	1	3	2	48
CDF	4	5	5	5	2	4	4	3	5	9	6	7	59
IDF	2	1	2	2	2	2	1	2	1	1	0	2	18
% Correct													50%
AVG[l]													
CTF	1	1	1	2	2	2	2	2	1	1	2	2	19
ITF	0	0	0	0	0	0	0	0	0	0	0	0	0
CDF	9	10	10	9	9	9	9	9	10	10	9	9	112
IDF	1	0	0	0	0	0	0	0	0	0	0	0	1
% Correct													99%

[a]A turning point is defined as: if actual loan volume increases (decreases) one month, then decreases (increases) the next, a turning point (change in direction) is observed. Two or more consecutive months of loan volume increases (decreases) indicate an up trend (down trend).

[b]See Table 1.

[c]See text for model definitions.

[d]Correct turn forecast. Forecast model correctly predicts a turning point; i.e., actual forecast loan volume increases (decreases) one month, then decreases (increases) the next.

[e]Incorrect turn forecast. Forecast model incorrectly predicts a turning point; i.e., actual loan volume increases (decreases) two months in a row, while forecast indicates a turning point or actual loan volume increases (decreases) one month, then decreases (increases) the next, while forecast indicates loan volume decreases (increases) one month, then increases (decreases) the next.

[f]Correct trend forecast. Forecast model correctly predicts direction of loan volume movement; i.e., actual and forecasted loan volume increases (decreases) two months in a row.

[g]Incorrect trend forecast. Forecast model incorrectly predicts direction of loan volume movement; i.e., actual loan volume increases (decreases) two months in a row, while model predicts decrease (increase) in loan volume two consecutive months.

[h]Total correct (CTF + CDF) as a percentage of total correct plus total incorrect (CTF + CDF + ITF + IDF).

[i]Total indicates total number of CTF, ITF, CDF, and IDF for the twelve, twelve-month forecasts. It is found by adding the values for each individual forecast series in the row.

Summary and Conclusions

The purpose of the study was to compare various models' performance in forecasting Sixth District FICB loan volume outstanding, in particular, to compare the performance of an averaging (AVG) model used by Bank management to forecast monthly loan volume with the predictive ability of two econometric models, an ARIMA model, and two composite models.

With respect to average MSPEs and average absolute errors, the econometric dummy (ECOND) model and both composite models (ECON-ARIMA and ECOND-ARIMA) outperformed the other forecast models. Of those three, both composite models were slightly better predictors than the ECOND model when comparisons were only based on average MSPEs. When individual MSPEs and average absolute errors were examined, the ECOND-ARIMA composite model slightly outperformed the ECON-ARIMA model. The FICB's AVG model performed the poorest under all comparisons.

The models that showed the lowest MSPEs were not necessarily the best at predicting directional accuracy. The AVG model substantially outperformed all other forecast models with respect to predicting turning points and trends. Among the other models, no model clearly stood out as second best.

The conclusions that follow are specific to the data used, the models examined, and the time period studied. Therefore, caution must be used in applying conclusions to other data, models, time periods, and forecast horizons. The results suggest the following recommendations. For predictive accuracy, the ECOND model or either composite model would be preferred to the AVG model currently used by the Bank. The ECOND and ECOND-ARIMA models are preferred to the ECON-ARIMA model because the latter requires the forecasting of three exogenous variables before predicting the dependent variable. Such a procedure is likely to increase forecast error. The ECOND-ARIMA composite model and ECOND model avoid the ex ante criticism because neither model contains structural variables. Consequently, the ECOND and ECOND-ARIMA models are likely to outperform the ECON-ARIMA model over an ex ante time frame. The structural econometric (ECON) model's value may lie in its ability to aid Bank officers whose task it is to anticipate how changes in structural variables would affect loan volume outstanding.

The choice between the ECOND model or the ECOND-ARIMA composite model is a question of cost versus benefit. The ECOND model is simpler and less costly to use, but the ECOND-ARIMA model may hold a slight edge in forecast performance.

When turning point prediction and trend accuracy are more important than point accuracy, model choice is clear. The AVG model is superior to all other models evaluated.[6] The fact that the AVG model did not show the lowest MSPEs and average absolute errors, and for that matter, exhibited the poorest summary statistics among the models evaluated, suggests that Bank management may want to use the ECOND model or the ECOND-ARIMA composite model to forecast monthly loan volume outstanding and the AVG model to predict turning points and trends.

Further research might involve exploring several forecasting alternatives not evaluated here. One possibility is to experiment with combining forecasts that were made for the same month but that were generated at different times. Another alternative to explore is combining the AVG and ECOND model forecasts and the AVG, ECOND, and ARIMA model predictions. Those composite model forecasts could then be compared with models evaluated in this study. The Sixth District FICB recently began forecasting monthly loan volume outstanding with a model that uses the average percentage change in loans outstanding from 1982 to the current month. When more forecasts become available from that model, one might want to compare the forecast performance of the model with the AVG model evaluated here that uses average percentage change in loans outstanding from 1973 to the current period to project monthly loans outstanding. The more current model might more adequately reflect the slow down in loan volume growth that began in mid-1982.

[6]A word of caution, however. The AVG model shows a strong tendency to overpredict. That is probably a reflection of the time period over which the historical average percentage change in loans outstanding was computed. Over a different time period, especially a period marked by the absence of a strong up trend in loan volume outstanding, the Bank's averaging model would probably not perform as well.

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A Comparative Analysis of the Return to Equity and Weighted Average Cost of Capital Approaches to Capital Budgeting

John R. Fiske

Abstract

Two widely used variations on the net present value formula—the weighted average cost of capital approach and the return to equity approach—are reconciled for both the single period and the multiperiod case. In both cases, the differences in net present values emerging from the two approaches can be attributed to alternative assumptions about the value and incidence of debt capacity.

Key words: return to equity, weighted cost of capital, project financing, capital budgeting theory.

The net present value method of investment analysis is widely endorsed by agricultural economists in textbook exposition of capital budgeting theory as well as in research on the determinants of capital expenditures by farm and agribusiness firms. The method has important applications both as a prescriptive tool and as an explanatory model of farm investment behavior.

One unresolved issue among agricultural economists with respect to that method is the proper way of handling the impact of project financing. The agricultural economics literature supports two approaches, generally referred to as the weighted average cost of capital approach (WACC) and the return to equity (RTE) approach. The former derives from corporate finance while the latter has been largely confined to the agricultural economics literature. On conceptual grounds, preference for the RTE approach often relates to concerns about the size and structure of farm units and the efficiency of agricultural capital market.

Despite procedural differences, both approaches are consistent with the belief that financing matters in the determination of net present value. However, they normally result in different net present values for identically specified investments. The purpose of this paper is to examine the conceptual basis for those approaches and to determine the conditions under which they can be reconciled.

The most important conclusion with regard to the conceptual basis of the two approaches is that the RTE approach undermines critical assumptions of the net

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present value rule. On strictly procedural grounds, the RTE approach proves to be inconsistent with prevailing views on the incidence and value of borrowing capacity over the life of an investment project.

The remainder of the paper consists of six sections. The first section will define the alternative approaches to the net present value formulation. The section following will critique the conceptual basis for the RTE approach. The third and fourth sections will reconcile the two approaches for the single and multiperiod project, respectively. The fifth section will comment on the multi-project firm, and the final section will present conclusions.

Defining the Alternatives

Under either approach the criterion for project acceptance, a positive net present value, is identical. Procedurally, the RTE approach discounts the net after-tax cash return to equity by the equity owner's discount rate (Barry, Hopkin, and Baker; Penson and Lins). The distinguishing feature of that approach is the inclusion in the cash flow calculations of principal and interest payments on the particular loan used, or expected to be used, to finance the investment.

Algebraically, the approach is expressed as follows:

$$NPV = \sum_{t=1}^{T} \frac{[C(t) - r(t)D(t)](1-\tau) - P(t)}{(1+k_e)} - E_o \quad (1)$$

where

$C(t)$ = cash flow before interest and taxes in period t,
$r(t)$ = interest rate in period t,
τ = marginal tax rate on ordinary income,
$D(t)$ = total debt outstanding in period t,
$P(t)$ = principal paid in period t,
k_e = opportunity cost of equity capital, after tax,
E_o = initial equity investment (down payment) in the project.

The net cash flow described by the equation above represents cash available to the equity owner. Assume salvage value to be zero. The equity discount rate, k_e, represents the equity owner's opportunity rate of return or the expected return to equity committed to an investment with identical risk characteristics.

The WACC approach, described in textbooks by Lee, et al., and by Casler, Anderson, and Aplin, uses a weighted average discount rate to reflect the relative contributions of debt and equity to the investment project. The cash flows developed for that approach do not recognize interest or principal payments. However, the net present value emerging from the formulation represents a return to equity capital just as in the RTE approach. Those two approaches are thus intended to measure the same thing—the net contribution of the particular investment project to the market value of the firm's equity.

Algebraically, the WACC approach is expressed as

$$NPV = \sum_{t=1}^{T} \frac{C(t)(1-\tau)}{(1+k_w)} - I_o \quad (2)$$

where

$C(t)$ = cash inflow before interest and taxes in period t,
τ = marginal rate on ordinary income,
k_w = the firm's weighted average cost of capital, after tax,
I_o = the initial total investment in the project.

The value of k_w is generally deemed to reflect the marginal costs of debt and equity capital weighted by their anticipated market value proportions in the firm's optimal or desired capital structure (Lee, et al., p. 75).

Accordingly,

$$k_w = w_d\, k_d + w_e\, k_e$$

where

k_d = the after-tax cost of debt capital,
k_e = the after-tax cost of equity capital,
w_e and w_d = the proportions of debt and equity capital, respectively, in the optimal or desired capital structure of the firm.

As reflected in their formulas, the only important difference between the two approaches is the level of debt the project is assumed to support over its life. In the case of the RTE approach, the level is implied by the amortization schedule embedded in the cash flows. That level is completely exogenous to the project's profitability (one may argue that farm lenders use "rules of thumb" in lending decisions that are related to the asset being financed—but, the level of debt still is exogenous). Moreover, it is restricted to actual borrowing. The RTE approach does not credit a project with borrowing capacity in excess of that actually used in borrowing.

In the case of the WACC approach, the level of debt is predicated on the existence of an optimal capital structure and is directly related to the profitability of the project. The higher the project's net present value, the greater the project's debt capacity.

To determine the dollar amount of debt capacity accruing to an incremental investment under the WACC approach, the proportion w_d is multiplied by the value of the incremental investment. A problem arises, however, in that there are two value concepts to consider. The first, termed by Copeland and Weston (p. 279) the replacement value, is defined as the economic cost of putting the investment into place, or ΔI. The second, termed the reproduction value, is defined as the total present value of the stream of cash flows expected from the investment, or ΔV. The difference between those two values is the net present value of the investment, $NPV = \Delta V - \Delta I$. Thus, to the extent that the reproduction value of an investment exceeds its replacement value, net present value is positive, and the firm's debt capacity in dollar terms will have increased as a result of making the investment.

To illustrate, if a \$1,000 incremental investment yields a present value of \$1,300, its net present value is \$300. Assuming that $w_d = .50$, the investment's dollar debt capacity, based on replacement value, is \$500. Based on reproduction value, the debt capacity is \$650. Most writers, although agreeing that the ratio expressed by w_d should equal the desired ratio D/V, also agree that the dollar debt capacity of an incremental investment should be expressed as $w_d(\Delta I)$ (Beranek). In the example just given, the investment analysis would proceed on the assumption that the dollar debt capacity of the incremental investment is $w_d(\Delta I) = \$500$. The fact that the net present value of the investment is \$300 indicates that by undertaking the investment, the firm can increase its debt capacity by $w_d(\Delta V - \Delta I) = \$150$.

The issue emerges as an important one in the comparison of the WACC and RTE approaches. Procedurally, the RTE approach defines the debt capacity of an incremental investment in terms of a dollar amount (i.e., ΔD), and the WACC approach defines it in terms of a ratio, w_d. Under the WACC approach, debt capacity will be a constant proportion of project value whether that value is defined as ΔV or as ΔI. Under the RTE approach, the percentage debt capacity of an incremental investment will differ depending on which definition of project value is used. That is, the ratio $\Delta D/\Delta I$ will not equal $\Delta D/\Delta V$ except in the special case where $NPV = 0$.

Assessing the Conceptual Basis for the RTE Approach

Before reconciling the procedural differences between the two approaches it is necessary to examine the major conceptual difference between them. Despite its detractors (Arditti and Levy; Myers), the WACC approach is the most widely accepted approach to the integration of investment and financing decisions, especially in textbook presentations. Moreover, the WACC has been shown to be consistent with the cost of capital measures emerging from the Modigliani-Miller model as well as the capital asset pricing model (Henderson). Why then would it not be the preferred approach in agricultural finance?

The arguments advanced in favor of the RTE approach relate to the size and organizational characteristics of the typical farm firm and the characteristics of capital markets in agriculture. Those arguments suggest that because proprietary firms likely face inefficient markets for both debt and equity, the RTE approach is more appropriate than the WACC approach. The purpose of this section is not to challenge any of those

assumptions but to demonstrate how they are largely irrelevant to the key differences between the RTE and WACC approaches.

The starting point for this analysis will be a review of the theoretical foundations for the net present value rule. Perhaps the most significant property of the net present value rule is that the maximization of the net present value is consistent with the maximization of the investor utility with respect to time preference for consumption. That means the investment policy of the firm, regardless of its ownership structure, can be directed toward maximizing net present value without concern for the utility functions of the investor(s). That property, however, depends on an equally significant assumption; that the investor(s) can borrow or lend at the market discount rate (the same rate used to calculate net present value). The result is seen most clearly in Figure 1, the familiar Fisher diagram.

The axes—labeled K_0 and K_1—represent consumption in the current and future period, respectively. The set of indifference curves labeled I_0 and I_1 reflect the time preference of an investor for consumption in each of the periods. The point W_0 represents the initial wealth of the investor that can be either consumed in the current period or invested in real or financial assets. The curve labeled W_0W_1 is the productive opportunity line which portrays the investment opportunities in real assets available to the investor. The investor chooses the most profitable investments first (i.e., those with the highest internal rate of return), thus the slope of the productive opportunity line diminishes with increasing investment in real assets.

In the absence of financial market opportunities, the utility maximizing level of investment is point C, the tangency of the productive opportunity line with the highest attainable indifference curve. The productive opportunity line also represents the investor's consumption possibility curve, and the optimal levels of consumption in the current and future periods, respectively, could be found by tracing lines to both axes from the point C. The investment decision clearly depends on the shape and location of the investor's indifference curves.

In the presence of an efficient financial market, the investor has the opportunity to borrow or lend at the market rate of interest and thus has expanded consumption possibilities. Borrowing and lending opportunities are reflected in the financial market line, an example of which is the line labeled $W_0^*W_1^*$ in Figure 1. The slope of the financial market line is the market rate of interest (i.e., the cost of capital). The basis for the net present value rule becomes clear. The firm invests up to the point where the internal rate of return equals the market rate of interest; by definition, the point where net present value becomes zero. That point is given by the tangency between the productive opportunity line and the financial market line—point A in Figure 1.

Point A represents the investment level that maximizes net present value (net present value is given by the distance, $W_0W_0^*$, in Figure 1). Importantly, that point does not depend on the investor's indifference curve. The investor maximizes his or her utility with respect to time preference for consumption by borrowing or by lending. Whether the investor is a borrower or a lender depends on the tangency of his indifference curve with the financial market line. That result, termed by Fisher the "Separation Theorem," is the basis for the notion that investment and consumption decisions are separable.

Figure 1 illustrates the case of an investor who maximizes his utility by consuming at C_0^* in the current period and C_1^* in the future period. But, C_0^* lies to the right of W_0, the investor's initial endowment. Moreover, the portion of that endowment given by the distance $A'W_0$ has been invested in real assets in the current period. Therefore, to achieve the consumption stream given by the point C^*, the investor must borrow the amount $A'C_0^*$ in the current period.

But assume that the firm and its owner are restricted in their borrowing, and that the restriction is independent of the profitability of the proposed investment. That is effectively what the RTE approach implies. That is also a precise definition of pure capital rationing (Weingartner).

Figure 2 illustrates the consequences of pure capital rationing for the two-period case.

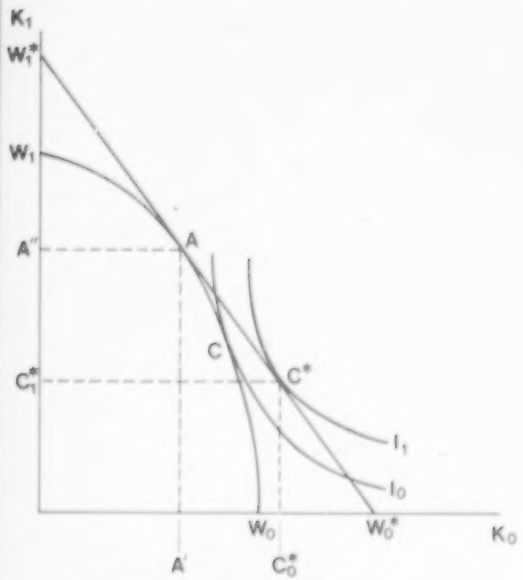

Figure 1: Two-Period Investment Analysis—No Capital Rationing

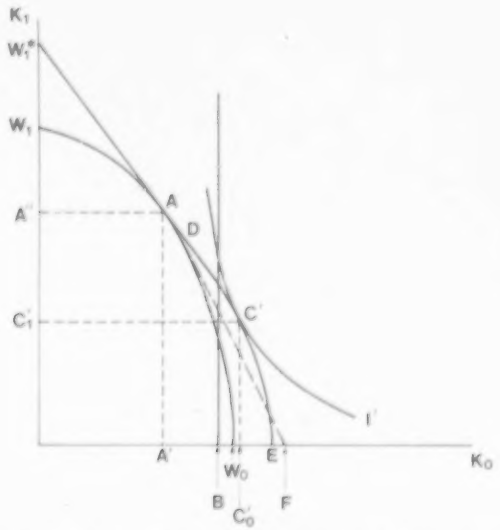

Figure 2: Two-Period Investment Analysis—with Pure Capital Rationing

Borrowing in the current period is restricted to the amount A'B. Thus, the portion of the financial market line to the right of the line originating from point B is unavailable to the firm or the investor. Assuming though that the firm can combine any level of investment on the productive opportunity line to the right of B with the amount of borrowing given by A'B, the relevant consumption possibilities curve becomes W*AE (W*AE is the financial market line until point B, but must lie below the financial market line to the right of B). The investor represented by the indifference curves in Figure 2 chooses utility maximizing consumption at point C', consuming at point C_0' in the current period, and C_1' in the future period. That corresponds to investment in the current period at point D on the productive opportunity line.

Point D is a tangent to the productive opportunity line with a slope equal to the tangent of the investor's indifference curve with the consumption possibility curve. That slope, which may be identified as 1+r', represents the appropriate discount rate to use in discounting cash flows when the borrowing restriction is binding. That slope is necessarily steeper than the slope of the financial market line, and thus the value of r' is greater than the market rate of interest. But the discount rate r' cannot be used as the opportunity rate of return in the RTE approach because it cannot be determined prior to the analysis. Moreover, as the borrowing constraint changes, so does the value of r'.

Thus any discount rate used in calculating net present value under the RTE approach is necessarily arbitrary. Fisher's separation theorem no longer holds; we have to know the location of the investor's indifference curve in order to calculate net present value. The WACC does not suffer from the same problem. The WACC approach implies only that the firm is able to raise capital in the specified proportions.

There are other arguments used to support the RTE approach, but to the extent that they are based on the assumption of borrowing restrictions, they are invalid.

Reconciling the Alternatives: the One-Period Investment

Ignoring the conceptual difference between the two approaches, their formulas can be reconciled by equating the explicit weighted average cost of capital employed in the WACC approach with that implied by the RTE approach. The WACC approach establishes a

weighted average cost of capital via an ex ante rule (i.e., k_w is the value that conforms to the firm's optimal or desired leverage ratio). The RTE approach can yield an implied weighted average cost of capital, but it does so ex post. However, it is valid to compare the two because both approaches express the same objective function, the maximization of equity owner's wealth.

Algebraically, the reconciliation is achieved by setting Equation 1 equal to Equation 2 and solving for k_w. Assuming that the firm consists of a single, one-period investment, abstracting from depreciation, and dropping the time subscripts

$$\frac{(C-rD)(1-\tau)-D}{1+k_e} - E = \frac{C(1-\tau)}{1+k_w} - I \qquad (3)$$

Setting $D = I - E$ and rearranging the value of k_w (which will be designated k_w') is

$$k_w' = \frac{C(1-\tau)}{\dfrac{C(1-\tau) + rD\tau - D(1+r)}{1+k_e} + D} - 1 \qquad (4)$$

The numerator in that expression is the after-tax cash flow from the investment before financing costs. The denominator is the total present value of the cash flows resulting from the incremental investment (i.e., ΔV). Total present value consists of the present value of equity which is the sum of the after-tax cash flow plus the tax shield on interest paid on debt minus the debt principal and interest payment,

$$\frac{C(1-\tau) + rD\tau - D(1+r)}{1+k_e}$$

and the present value of debt,

$$D = \frac{D(1+r)}{1+r}$$

where the market value equals the sum of principal and interest payments discounted by the debt holder's discount rate which is the interest rate charged on the debt.

The value of k_w' is that which equates the net present value under the WACC approach with the net present value of the RTE approach. The comparison of k_w' with k_w will be made with the use of a numerical example.

Assume that a firm consists of a single investment project that requires an outlay, ΔI, of \$300 at time t=0 and yields a cash flow of \$500 at time t=1. The investment will be financed with \$150 in equity and a loan of \$150 repayable with interest at 10 percent at t=1 (assume w_d=.5).

The investor's equity capitalization rate is assumed to be 20 percent, after tax and the marginal income tax rate, 30 percent. The net present value of the investment via the RTE approach is

$$NPV(R) = \frac{(\$500-\$15)(1-.3) - \$150}{(1+.2)} - \$150$$

$$NPV = \$7.92.$$

The calculation implies, according to Equation 4, a weighted average cost of capital of

$$k_w' = \frac{\$350}{\dfrac{(\$350+\$4.5-\$165)}{1.20} + \$150} - 1$$

$$k_w' = 0.1367$$

Substituting $k_w' = .1367$ for k_w in the WACC formula and solving for NPV(W)

$$NPV(W) = \frac{\$500-\$150}{1.1367} - \$300$$

$$NPV(W) = \$7.91$$

Note especially that the two approaches can be reconciled only when the debt capacity reflected in the WACC approach is given by the ratio $\Delta D/\Delta V$. To show that, calculate k_w by first using $w_d = .50$,

$$k_w = .10(1-.3)(.5) + .20(.5)$$

$$k_w = 0.135,$$

and second by using $w_d = \Delta D/\Delta V$, where $\Delta D = w_d(\Delta I)$,

$$k_w = .10(1-.3)\left(\frac{\$150.00}{\$307.92}\right) + .20\left(\frac{\$150.00}{\$307.95}\right)$$

$$k_w = 0.1367.$$

Thus the weighted cost of capital implied by the RTE approach, k_w', is based upon a

marginal debt capacity given by the ratio $\Delta D/\Delta V$ where ΔD is the dollar amount of the incremental investment financed by debt.

It can be shown by an extension of the numerical example that as the investment's net present value grows due to a larger net cash flow, the dollar gap between NPV(R) and NPV(W) will widen. That occurs because for a given ΔD, the difference between $\Delta D/\Delta I$ and $\Delta D/\Delta V$ widens as net present value increases. As illustrated in Table 1, when net present value is positive, NPV(W) will always exceed NPV(R), and when net present value is negative, NPV(R) will always be less negative than NPV(W). The ratio of NPV(W) to NPV(R) is established by the ratio (1+ke)/(1+kw) and will not change with a change in net cash flow. However, it will vary with a change in w_d as shown in Table 1.

The Multiperiod Investment

In the multiperiod case, reconciliation of the RTE and WACC approaches requires that $k_w = k_w'$ for each period. Over the life of an investment, the actual proportion of funding from alternative sources may change as the debt is amortized and the relative values of the debt and equity contributions to the project change.

The WACC approach, as usually employed, assumes that those contributions remain constant in proportion throughout the life of the investment. Implicit in that reasoning is the assumption that the proportion of debt to equity used in the weighted average cost calculation represents an optimum.

Under the RTE approach, the debt capacity of an investment project in any period is determined by the amortization schedule used in calculating cash flows. The debt may be amortized in such a way as to maintain a constant debt-to-equity ratio over the life of the investment.

The implication for k_w' over the life of the investment can be seen from a numerical example. Assume again that a firm consists of a single investment project but that the investment will last for five periods. Other characteristics of the investment are

Investment outlay	$9,000
Annual cash flow before the interest, principal, and taxes	$5,000
Marginal tax rate	30%
Cost of equity capital, after tax	20%
Cost of debt capital, before tax	10%

Further assume that the firm will finance the project with a loan of $4,500 payable in equal principal payments with the interest calculated on the unpaid balance. The cash flows for the project are shown in Table 2.

The net present value of the investment calculated at period t=0, using the RTE approach is

$$NPV(R) = \frac{\$2,285}{(1.2)} + \frac{\$2,348}{(1.2)^2} + \frac{\$2,411}{(1.2)^3} + \frac{\$2,474}{(1.2)^4} + \frac{\$2,537}{(1.2)^5} - \$4,500$$

$$NPV(R) = \$2,643$$

Table 1: A Comparison of NPV(W) and NPV(R) at Different Levels of Net Cash Flow and Different Values of W_d

	$w_d = .50$		$w_d = .75$	
Cash Flow	**NPV(W)***	**NPV(R)**	**NPV(W)**	**NPV(R)**
$200.00	$-177.00	$-167.00	$-173.00	$-159.00
400.00	-53.00	-50.00	-46.00	-42.00
500.00	8.37	7.92	17.46	16.04
600.00	70.00	66.00	81.00	74.00
800.00	193.00	183.00	208.00	91.00

*The ratio NPV(W)/NPV(R) is 1.0568 and 1.0885, respectively, for $w_d = .50$ and $w_d = .75$.

Table 2: Cash Flows for Multiperiod Investment Analysis

	Period				
	1	**2**	**3**	**4**	**5**
Cash inflow	$5,000	$5,000	$5,000	$5,000	$5,000
Interest expense	450	360	270	180	90
Taxes	1,365	1,392	1,419	1,446	1,473
Cash flow after taxes and interest	3,185	3,248	3,311	3,374	3,437
Principal	900	900	900	900	900
Cash return to equity	2,285	2,348	2,411	2,474	2,537

Table 3: Market Value of Investment at the Beginning of Period

	1	**2**	**3**	**4**	**5**
Debt value	$4,500	$3,600	$2,700	$1,800	$900
Equity value	7,144	6,286	5,195	3,823	2,114
Total value	11,643	9,886	7,895	6,623	3,014
D/V	.3864	.3642	.3420	.3201	.2986
k_w'	.1498	.1527	.1555	.1584	.1612

Using the WACC approach, the net present value of the project at t=0 is

$$NPV(W) = \sum_{t=1}^{5} \frac{\$5{,}000\ (1-.3)}{(1.135)} - \$9{,}000$$

$$NPV(W) = \$3{,}162$$

As in the one-period case, the difference between the two net present values arises because of the different assumptions about debt capacity. Under the WACC approach, debt capacity remains proportional to the market value of the investment throughout its useful life. Thus, $k_w = .135$ in all periods. On the other hand, the value of k_w' may vary over the life of the investment. That is shown in Table 3 where the market values of debt and equity are calculated as of the beginning of each succeeding period of the investment's life.

As the debt is amortized, the relative contributions of debt and equity to the financing of the investment will change and with them, the value of k_w', the implied weighted averaged cost of capital. Of course, the change in k_w' is specific to the amortization schedule. Given the amortization schedule of the example, the relative contribution of equity capital becomes larger in the later periods in the investment as the leverage ratio declines. Because the cost of equity capital is higher than the cost of debt capital, the weighted average cost of capital likewise becomes larger.

Figure 3 illustrates the difference in the two capital budgeting approaches in accounting for the value of debt capacity in the multiperiod case. Assume V_t represents the market value of a finite-lived asset over its useful life. The line labeled K_t represents the debt capacity of the asset as perceived by lenders. K_t is a constant proportion of V_t. The line labeled L_t represents the optimal borrowing level (i.e., the borrowers' optimal allocation of debt capacity to borrowing and reserve credit, respectively). Finally, D_t represents the market value of the particular debt actually used to finance the assets' purchase.

The value of debt capacity assigned to the investment under the RTE approach is given by the area under D_t. The value of debt capacity assigned by the WACC approach is given by the area under L_t. Because L_t reflects the optimal allocation of debt capacity to borrowing and reserve credit, it

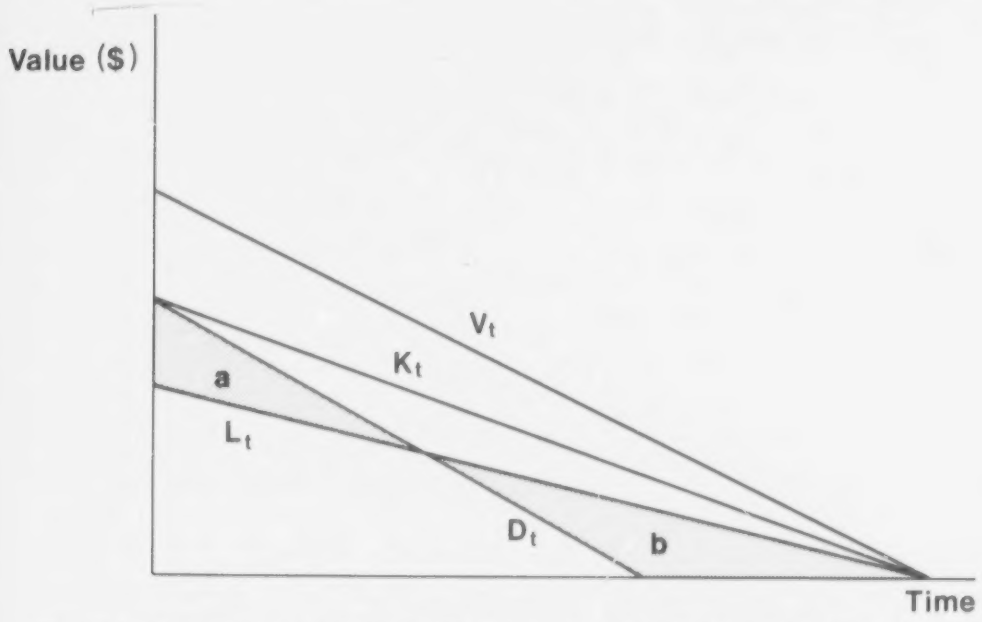

Figure 3: Alternative Valuations of Debt Capacity in the Multiperiod Case

implicitly accounts for the liquidity value of unused credit.

The shaded area labeled *a* measures the debt capacity attributed to the investment by the RTE approach but not the WACC approach. The area labeled *b* measures the debt capacity attributed by the WACC approach but not by the RTE approach.

Other things being equal, the implied weighted average cost of capital under the RTE approach, k_w', would be less than k_w to the left of the intersection of L_t and D_t and greater than k_w to the right of it.

The Multiproject Firm

In dealing exclusively with the single project firm, this paper has avoided an important issue in capital budgeting; namely, how to analyze incremental investment opportunities that are radically different in their risk characteristics from the rest of the firm's assets. The concern with regard to financing is that incremental assets may have different debt capacities and imply different optimal leverage ratios so that the leverage ratio developed for assets with given risk characteristics may not apply to subsequent investments. An attendant problem is the risk interdependency of incremental investments and existing assets in the face of less than perfectly correlated returns. The existence of risk interdependence could likewise invalidate the use of an optimal leverage ratio in assessing incremental investments.

One might argue that the problem is not too important in agriculture because many farm businesses are virtually "single project" firms, that project being farmland, and that other investments are small by comparison. An assumption of risk independence may also be defensible given the availability of other options to control risk such as insurance, hedging, diversification of personal wealth, or the maintenance of reserve credit.

However, the problem is not crucial to the present discussion because neither of the approaches discussed clearly addresses the issue. The WACC approach requires the necessary condition that incremental projects be identical in risk characteristics to the existing assets of the firm (or of "average risk"). If a potential investment is more or less risky than the firm's existing assets (if it differs from average), the WACC approach is not appropriate. The RTE approach treats borrowing as exogenous so there is no explicit link between project riskiness and

debt capacity.

The particular characteristics of the multiproject firm are relevant to the comparison between the RTE and WACC approaches in other contexts, however. By considering project-specific financing, the RTE approach runs the danger of attributing value to a project that is rightly attributable to the condition of the firm's existing balance sheet. Highly leveraged investments may reduce future financing options. The RTE approach has no systematic way of considering that cost in determining net present value.

Conclusions

This paper has focused on the differences between the RTE and WACC approaches to calculating net present value. It has been asserted that the RTE approach implies the case of pure capital rationing, and it has been demonstrated that the existence of pure capital rationing undermines the rationale of the net present value method.

That important conceptual difficulty aside, it has also been demonstrated that the RTE approach is not consistent with prevailing views on the value and incidence of debt capacity over the life of an investment project. The RTE approach credits an investment project only with the portion of the debt capacity (or credit) actually used in borrowing. Thus, as debt is amortized, as in the multiperiod case presented here, a decline necessarily occurs in debt capacity as well. However, debt capacity is normally defined as a proportion of asset value, and in the case of many farm assets, most notably farmland, farmers may gain valuable credit reserves as they amortize their mortgage debt.

The concerns about the particular organizational and institutional characteristics of farm finance that seem to underlie the use of the RTE approach are important and need to be considered in the capital budgeting process. The RTE approach, however, does not properly address those concerns.

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Effects of Monetary Changes on the Price Level and Output in the U.S. Agricultural Sector

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Abstract

The U.S. agricultural sector is often subjected to external shocks such as changes in the money supply. A change in the money supply may have an important impact on agricultural output and prices. This study empirically investigates two issues: the question of causality in the money-income relationship (as applicable to the agricultural sector) and the effects of monetary changes on the two components of nominal farm product (prices and real farm product). The study finds that the impact of monetary changes operates primarily through price level changes at both the retail and the farm level.

Key words: money supply, causality, U.S. agricultural sector prices and output.

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Accelerating inflation in the late 1970s and early 1980s led to renewed interest in empirically testing the causes of inflation. Although several possible causes of inflation have been suggested, all causes can be broadly divided into two major categories. The first category is the Keynesian or structuralist explanation asserting that inflation is directly caused by real shocks in some sectors of the economy. Those exogenous shocks can be due to such factors as global crop failures and increases in prices of raw materials. The real shocks lead to a contraction in output that in turn increases prices. Those price increases are subsequently accommodated by an expansion in the money supply. According to this explanation, the stock of money is endogenously determined. Thus, causality is assumed to flow from changes in prices to changes in the money supply.[1] Consequently, the price level is exogenously determined.[2]

Monetarists, on the other hand, regard money as an independent source of economic disturbance. In their view, autonomous increases in the money supply cause prices to change. Ultimately, changes in the money supply lead to price level changes, leaving

[1]The origins of the debate of exogeneity versus endogeneity of the money supply can be traced to the eighteenth century Bullionist controversy and the Currency-Banking School debate of the nineteenth century. Recently that debate has been carried on by monetarists and Keynesians. For a further discussion of those issues, see Becker and Baumol (1952), Humphrey (1974), Makinen (1977), and others.

[2]The cost-push explanation of inflation asserts that true origins of inflation can be found only among the supply side factors such as crop failures, excessive wage claims, and increases in the cost of essential raw materials.

the economy's real output unaffected.[3] Consequently, the stock of money is exogenously determined, not the price level. Therefore, according to monetarists, causality flows from the money supply to nominal income.

Theoretically, those arguments raise two key questions: (a) Do changes in the money supply cause changes in nominal income? And (b) How do monetary changes affect the two components of nominal income—price level and real output? The second issue (the effect of monetary changes on the components of nominal income) centers on whether changes in the money supply lead only to changes in the price level (the monetarist long-run position) or whether real income is permanently affected (the Keynesian position).[4]

Because agriculture is viewed as a highly competitive sector of the American economy, prices within that sector are regarded as highly flexible. Because of the flexibility of food prices (retail), it can be postulated that changes in the money supply may lead to rapid increases (decreases) in food prices leaving real agricultural output unchanged (monetarist position). Alternatively, food prices may be determined by exogenous factors such as a crop failure, and the money supply may adjust only passively to accommodate higher prices (Keynesian position).[5]

The agricultural sector is often subjected to external shocks, so changes in the money supply and their effect on agricultural output and prices become critical. For instance, monetization of large federal deficits may have important impacts on the real income of the agricultural sector. Other issues include the effect of inflation on real interest rates and input costs in the agricultural sector. Those questions and others neccessitate a close examination of the relationships between macro influences in the economy and broad sectors such as agriculture.

Consequently, an empirical examination of the American agricultural sector involving causality testing between the retail and farm level variables can make a significant contribution toward resolving the above mentioned theoretical issues. In particular, it accomplishes two major objectives. First, it can measure the speed of adjustment of retail prices to changes in monetary variables. Second, it could indicate the impact, if any, of monetary changes on the actual real farm product. The test results should be of special interest to policy makers, agricultural producers, and agribusinesses as they contemplate the possible impact of government policy on the farm product and retail food prices.

The purpose of this paper is to search for empirical evidence in support of either the Keynesian or the monetarist positions as they relate to the American agricultural sector. That may provide a basis to judge the influence of changes in the money supply on the nominal product of the farm sector as a whole and to test the effects of monetary changes on the components of the nominal product of the farm sector, i.e., retail prices and real output. That will be accomplished by initially using a bivariate causality test based upon the Hsiao (1981, 1982) minimum final prediction error (FPE) causality detection method to test the first hypothesis (changes in the money supply affect nominal farm product).[6] The bivariate comparisons are then extended to a trivariate analysis to test the second hypothesis (monetary changes affect the two components of nominal farm product: price level and real farm product).

Empirical Considerations

Numerous empirical causality test procedures follow the concept of causality

[3]That long-term result can be expected to hold if income velocity remains unchanged, and if all price level changes are correctly anticipated by the market participants.

[4]For a detailed explanation see Friedman (1970, 1971, and 1972), Tobin (1970), Patinkin (1972), and others.

[5]For that explanation to hold true it is explicitly assumed that any changes in the price level are passively accommodated by the monetary authorities through an increase in the money supply. For a further discussion see the Radcliffe Report (1959), Gurley (1960), and Olivera (1970).

[6]The minimum FPE causality testing method involves an optimal lag selection in causality testing. That method is described in more detail in the following section of this paper. (See Hsiao 1981, pp. 87–93).

outlined by Granger (1969).[7] Several empirical studies used Granger causality test procedures to analyze macro data of the American economy. Those studies include the pioneering work of Sims (1972). Recent contributions to causality testing include work by Geweke et al. (1983); Guilkey and Salemi (1982); and Hsiao (1981 and 1982). Those studies attempted to establish a causal relationship between nominal income (approximated by nominal GNP) and either M_1 or M_2.[8]

A number of empirical studies addressed the question of causal flow from the money supply to agricultural prices. For example Bordo (1980) found that changes in the money supply have a significant impact on agricultural prices. Lawrence (1980) showed that the U.S. money supply and the stock of international reserves had an important impact on commodity prices in the 1970s. Similarly, Chambers and Just (1982) found evidence of causal flow among the U.S. money supply, the general price level, the exchange rate, and domestic agricultural prices. Barnett et al. (1983) deployed Granger-type causality tests to seek the causal flow between the U.S. money supply and domestic agricultural prices.

Although those studies of the American agricultural sector made significant contributions to the literature, they were deficient in two areas. First, even though causal flow may be empirically established from money supply to prices, that does not rule out at least a partial causal flow from the money supply to the real output of the agricultural sector. Theoretically, the question of whether changes in the money supply affect real output as well as prices is of crucial importance.

The appropriate lag specification of each test equation is the second important issue. With the exception of Hsiao's (1981 and 1982) work, most of the previous studies relied on the arbitrary lag selection in their causality testing. The causality test results obtained through the arbitrary lag selection may be unreliable because the distribution of test statistics can be sensitive to lag length.[9]

To overcome the problem of arbitrary lag selection, this study employs Hsiao's technique to choose the optimal lag length. Hsiao's procedure combines the minimum FPE criterion developed by Akaike (1969a and b) with Granger's (1969) definition of causality. According to Akaike (1969a), the estimate of $FPE_y[Y(m), X(n)]$ is defined as

$$FPE_y(m,n) = \frac{T+m+n+1}{T-m-n-1} \cdot Q_y(m,n)/T \qquad (1)$$

where m and n are the number of lags on Y and X respectively, T is the number of observations, and Q_y is the sum of the squares of residuals (SSE). Using the minimum FPE for the optimal lag selection is equivalent to applying an approximate *F* test with varying levels of significance. Therefore, Hsiao's optimality criterion of minimizing the mean square prediction error avoids the conventional ad hoc selection of 5 percent or 1 percent levels of significance. Consequently, the procedure overcomes the type I and type II errors associated with classical hypothesis testing.

Hsiao outlines three possible outcomes in causality testing. Given two variables, X and Y, X is said to cause Y if the prediction of Y using past values of X is more accurate than without using past X. Feedback occurs if X causes Y and if Y causes X. Finally, X and Y can be either statistically independent or only contemporaneously related. In that case, X does not cause Y, and Y does not cause X.[10]

Using Hsiao's first definition of causality (step 1), Y is treated as a one-dimensional autoregressive process. The FPE is then computed varying the order of lags from one to fifteen. The optimal lag operator for Y is determined by selecting the minimum FPE value from the fifteen FPE values calculated. Once the lag order for Y is determined, the

[7]The Granger (1969) causality approach states that Y causes X if and only if X is better predicted by employing the past history of Y than by not doing so.

[8]Sims (1972) also introduces the monetary base as one of the test variables.

[9]Biswas and Saunders (1985) use the Granger causality test procedure to test the exogeneity of M_1, M_2, and the monetary base in the money-income relationship. Their study finds that the causality test results are directly dependent upon the arbitrary selection of the lag structure. Therefore, causality test procedures that rely on arbitrary lag selection may yield unreliable results.

[10]For a further discussion of causality see Hsiao (1981, pp. 90–91).

process is completed by estimating X while maintaining the same lag specification for Y as determined in step 1 and varying the order of lags for X from one to fifteen. The optimal bivariate model (with the order of Y held constant from step 1 and the lags of X added) is then selected based on the minimum FPE criterion (step 2). Stated differently, the "best" univariate model is selected for Y, and then the "best" bivariate model is chosen assuming the same number of lags for Y as established in the univariate model. The next stage involves comparing the smallest FPEs of steps one and two. If the former is smaller than the latter, then a one-dimensional autoregressive representation for Y is used. If the opposite is true, then by definition X causes Y. Finally, the above steps are repeated using X as the initial variable to determine if a feedback relationship exists or if the causality is unidirectional.

In our calculations, X represents the money supply, and Y represents the nominal farm product. We use three different measures of the money supply, namely the monetary base (B), M_1 and M_2. The nominal farm product is measured by the nominal gross farm product (NGFP).[11] Additionally we use data for the real gross farm product (RGFP), the food at home component of the consumer price index (FHCPI), and the farm price index or prices selected by farmers (FPI).[12] The main reason for using the FHCPI variable is its suitability for measuring price changes at the retail level for agricultural prices. The FPI, on the other hand, approximates the price level changes at the farm level. Quarterly data from the first quarter of 1959 to the second quarter of 1984 are used for those variables. Quarterly data are more appropriate than any other shorter term data because changes in monetary variables usually affect the economy with a lag of several quarters. The equations are estimated in natural logarithmic form.[13]

[11]Monetary data were obtained from various issues of the *Federal Reserve Bulletin*. The nominal and real gross farm product data were obtained from the *National Income and Product Accounts of the United States, 1929–76* (1981), and from various issues of the *Survey of Current Business*.

[12]The food at home consumer price index is published by the Bureau of Labor Statistics.

[13]The natural log form specification alleviates problems associated with the nonstationarity of variables.

Bivariate Results

The first section of Table 1 reports the bivariate test results, and Table 2 indicates the implications of the causality tests. The first column in Table 1 summarizes the optimal lag specification for each test variable (step 1). Step 2 results are obtained by adding the second column. The test results indicated that feedback exists between M_1 and the NGFP as well as between M_2 and the NGFP. One possible explanation of that result can be found in considering the relationship of the agricultural sector to the entire U.S. economy. The output of the agricultural sector accounts for some 20 percent of GNP. Consequently, the conditions prevailing in the sector, such as the demand for loans, may indeed have some impact on M_1 and M_2. Thus, the existence of the feedback between M_1, M_2, and NGFP can be theoretically explained. However, when the monetary base is used as the measure of money, then a direct causal relationship between the monetary base and the NGFP is established (i.e., the monetary base causes NGFP). Consequently, using the monetary base as an approximation of the money supply gives empirical support to the monetarist position concerning causality in the money-income relationship.

Empirical evidence presented in Table 1 suggests that it is the change in the monetary base that leads to subsequent changes in nominal agricultural sector income. Using the monetary base as a proxy for the money supply we find no empirical support for the structuralists' assertion of the endogeneity of the money supply with respect to retail food prices. That evidence accords with the results reported recently by Barnett et al. (1983). Of special empirical interest is the fact that although the causality implications of our study agree with those of Barnett et al., our causality testing technique is different.[14] Thus our statistical analysis appears to validate their results.

Statistical results reported in Table 3 indicate the size of the impact of changes in the monetary base on the nominal gross farm

[14]Barnett, Bessler, and Thompson (1983) use the Granger-type causality testing procedure that relies on the arbitrary lag selection.

Table 1. Causality Testing by Computing Final Prediction Error (FPE) of the Controlled Variable[a]

Equation	Controlled Variable	First Manipulated Variable	Second Manipulated Variable	FPE × 10 ^{4}
	I. Bivariate Results			
	NGFP (2)			41.1230
	M_1 (8)			0.5028
	M_2 (2)			0.4216
	B (11)			0.1689
(2)	NGFP (2)	M_1 (8)		38.0070
(3)	M_1 (8)	NGFP (2)		0.4766
(4)	NGFP (2)	M_2 (1)		38.2910
(5)	M_2 (2)	NGFP (4)		0.4177
(6)	NGFP (2)	B (1)		38.1390
(7)	B (11)	NGFP (1)		0.1710
	II. Trivariate Results			
	RGFP (3)			0.9407
	B (11)			0.1689
	FHCPI (6)			2.1366
	FPI (1)			26.1260
(8)	RGFP (3)	FHCPI (1)		23.6617
(9)	FHCPI (6)	RGFP (4)		2.0882
(10)	RGFP (3)	FPI (1)		31.7480
(11)	FPI (1)	RGFP (1)		26.3440
(12)	RGFP (3)	FHCPI (1)	B (1)	22.7634
(13)	FHCPI (6)	RGFP (4)	B (1)	1.9197
(14)	RGFP (3)	FPI (1)	B (2)	31.1700
(15)	FPI (1)	RGFP (1)	B (2)	25.7460

[a]Numbers in parentheses in columns 2, 3, and 4 are lags for minimum FPE.

product. Because there appears to be a unidirectional causal flow from monetary base to the nominal gross farm product, an indication of the magnitude of the effect of changes in the money supply on the nominal gross farm product can be obtained by considering the coefficient of the lagged monetary base variable in Equation 6. Although this number should be interpreted with caution, 0.151 indicates a substantial positive effect of changes in the monetary base (B) on nominal gross farm product (NGFP). Or, ceteris paribus, a $1 billion increase in the monetary base implies approximately a $150 million increase in nominal gross farm product within one quarter.

Using M_1 and M_2, the Keynesian position cannot be rejected because we find evidence of feedback. That would suggest that both of those measures of the money supply are somewhat endogenous. As explained previously, the results can be theoretically justified. An additional explanation for those results can be found in economic theory itself. Economic theory suggests that only the monetary base can be regarded as truly exogenous, because both of its components are directly under the control of the Federal Reserve.[15] M_1 is defined as m×B, where B is the monetary base, and m is the money multiplier. Several components of the money multiplier are endogenous.[16] Similar theoretical arguments apply to M_2. Consequently, we find no inconsistency in the causality results reported in Table 2. Those results are theoretically justified and empirically expected.

Trivariate Results

The bivariate results provide useful information about the role of money as a causal force in determining the nominal farm product in the agricultural sector. In the case of the monetary base, empirical evidence

[15]For a further discussion of the exogeneity issue and some empirical evidence, see Cagan (1965), Brunner and Meltzer (1964), Andersen and Jordan (1969), and others.

[16]Siegel (1982, pp. 135–144) describes those components.

Table 2. Causality Implications of the FPE Procedure for NGFP, B, M_1, and M_2

B		M_1		M_2	
Process	Implications	Process	Implications	Process	Implications
NGFP Process:		*NGFP Process:*		*NGFP Process:*	
FPE (Step 1) 41.123	41.123 > 38.139	FPE (Step 1) 41.123	41.123 > 38.007	FPE (Step 1) 41.123	41.123 > 38.291
FPE (Step 2) 38.139	B => NGFP	FPE (Step 2) 38.007	M_1 => NGFP	FPE (Step 2) 38.291	M_2=>NGFP
B Process:		*M_1 Process:*		*M_2 Process:*	
FPE (Step 1) 0.1689	0.1689 < 0.1710	FPE (Step 1) 0.5028	0.5028 > 0.4766	FPE (Step 1) 0.4216	0.4216 > 0.4177
FPE (Step 2) 0.1710	B => NGFP	FPE (Step 2) 0.4766	NGFP => M_1	FPE (Step 2) 0.4177	NGFP => M_2

Table 3. Autoregressive Estimates of Equations 6 and 7

Equation 6				Equation 7			
Statistics		Lags	Coefficients (*t* statistics)	Statistics		Lags	Coefficients (*t* statistics)
R^2	0.98641	ln NGFP (-1)	1.150 (11.493)	R^2	0.99998	ln B (-1)	1.366 (12.698)
S.E. of regression	0.0606	(-2)	-0.273 (-2.775)	S.E. of regression	0.0038	(-2)	-0.481 (-2.6431)
DW	2.06			DW	1.95	(-3)	0.311 (1.647)
F	2322	ln B (-1)	0.151 (3.082)	F	104050	(-4)	-0.311 (-1.587)
						(-5)	0.164 (0.833)
						(-6)	-0.034 (-0.176)
						(-7)	-0.074 (-0.380)
						(-8)	-0.074 (-0.387)
						(-9)	-0.080 (-0.425)
						(-10)	-0.363 (-2.012)
						(-11)	-0.298 (-2.906)
						ln NGFP (-1)	-0.002 (-0.880)

suggests a unidirectional causal flow from money to a nominal agricultural product. However, the initial causality tests did not indicate to what extent the monetary changes affect the two components of nominal gross farm product: price level and real gross farm product. According to monetarists changes in the money supply can eventually only affect the price level leaving real output unchanged.[17] Conversely, Keynesians claim that under conditions of less than full employment, changes in the money supply can permanently affect the economy's output and employment.[18] Resolution of that important issue requires empirically identifying the existence and strength of the causal flow from the monetary base to agricultural prices and real farm product. That evidence can be obtained by extending the previous bivariate causality test into a trivariate analysis by separating the components of nominal gross farm product into price level and real farm product.

The Granger method for testing causal relationships in bivariate contexts can be extended to multivariate formulations.[19] However, the Granger method has two serious drawbacks. In the first place, as previously explained, its reliance on the arbitrary lag length selection may seriously influence the test results. Second, increasing the lag length rapidly diminishes the degrees of freedom. Both of those problems are overcome when the FPE procedure is extended to a trivariate context.

To carry out a trivariate analysis with respect to the U.S. agricultural sector only, it was necessary to find a measure of the price level within the agricultural sector alone. Neither the consumer price index, nor the GNP deflator, nor any other inflation measure of an economy's overall prices could serve that purpose. There exists a number of possible choices of the measures of price changes in the U.S. agricultural sector. The most obvious choices of that variable are the farm price index, the implicit farm price deflator, the consumer price indices for domestically produced farm foods, and the food at home price index. Ram (1984, p. 473) suggests that in causality testing there may be some advantage in using a price level variable that is independent of real output. Consequently, two different measures of agricultural price changes are used in the trivariate analysis. The farm price index (FPI) assesses the effect of monetary changes on prices at the farm level, and the food at home consumer price index measures that effect at the retail level.[20] The food at home component of the consumer price index (FHCPI) can be regarded as a useful proxy for retail level price changes in the agricultural sector. Therefore, the quarterly data for the FPI and the FHCPI are used throughout the trivariate analysis.

The trivariate results are reported in the second section of Table 1. The last two rows of Table 1 enable us to draw inferences about the direction of the causal flow from the monetary base to agricultural prices and the real gross farm product. There appears to be evidence of a causal flow from the monetary base to both components of nominal gross farm product. When the price changes are approximated by the FHCPI, then the addition of the lagged monetary base term to the price level equation (13) reduces the FPE from 2.0882 to 1.9197. Similarly an inclusion of the lagged monetary base term to the real output equation (12) reduces the FPE from 23.6617 to 22.7634.[21] Similar results are obtained when the price level changes are approximated by the FPI as indicated by Equations 14 and 15. That implies that regardless of the price variable used, the impact of the monetary variable on the nominal farm product operates both through price level changes and real output changes. Food prices at both the farm level

[17]The outcome is, of course, the long-term result. In the long term, money is neutral with respect to any real variables in the economy. In the short term, or the transition period, money may not be neutral. For a further discussion of that point, see Makinen (1977, pp. 29–94).

[18]Keynes (1936, pp. 295–296) outlines that point.

[19]Jarrett and Selody (1982) utilize a trivariate analysis of this kind.

[20]The consumer price index for domestically produced farm foods and the food at home consumer price index are very similar. The only minor difference between those two indexes is the relative weights assigned for items such as seafoods, sugar, seasoning, condiments, and some selected beef cuts.

[21]One possible explanation of the lag operator length for RGFP is the fixity of crop production in a given year. If adjustments could be made more quickly, then lag length could be increased to a larger order.

and the retail level seem to be affected by increases in the money supply.

A rough indication of the magnitude of the effects of monetary changes on both of those variables at the retail level is indicated by the values of the lagged coefficients of the monetary base variable in Equations 12 and 13. Those results are reported in Table 4. In the case of the real farm product equation (12), the coefficient of the lagged monetary base is negative and statistically insignificant at the 5 percent level of significance. The same coefficient in the price level equation (13) is positive and statistically significant. An interpretation of those results is that the monetary variable has an insignificant negative impact on the real farm product and a substantial and quite rapid positive impact on retail agricultural prices.[22] The trivariate causality test results indicate that the major impact of monetary changes on a nominal agricultural product operates through changes in retail agricultural prices and not through changes in the real product of the agricultural sector.

Conclusions

This study investigates two related theoretical issues. First it analyzes causality of money in the money-income relationship, and second it analyzes the effects of monetary changes on nominal retail prices and real agricultural output. The investigation focused on the agricultural sector of the U.S. economy. The study was motivated by the desire to determine the effects of monetary changes on nominal output and on the components of nominal output (real output and the price level) in an essentially competitive sector of the U.S. economy.

The minimum FPE causality testing technique used throughout the study overcomes some of the inherent difficulties in causality tests that rely on arbitrary lag selection. When the FPE causality test procedure is utilized, a unidirectional causal flow is established from the monetary base to the nominal gross farm product. That result is in accord with many empirical causality studies of the entire U.S. economy as well as with many recent studies of the agricultural sector. With respect to the agricultural sector, the novelty of our study lies not only in relying on a different causality testing method but also in emphasizing testing for the causal relationship between the money supply and the nominal gross farm product. Therefore, our analysis has not been limited to investigating the effects of monetary changes on agricultural prices alone. On the whole, our causality test results confirm the monetarist position with respect to the nominal income determination in the agricultural sector.

An important contribution of the study is contained within the trivariate analysis. Although many empirical studies provide useful information about the role of money as a causal force in determining agricultural prices, the resolution of the issue of the effects of monetary changes on the two components of the nominal gross farm product is perhaps of even greater importance.

The results can be of major importance for analyzing the effects of monetary policy on the U.S. agricultural sector. We find that the impact of monetary changes operates primarily through the price level changes at both the retail and the farm level. The results indicate a strong positive impact on monetary changes on agricultural prices and a negligible negative impact on the real farm product. One interpretation of those results is that an expansionary monetary policy has an important and an immediate impact on agricultural prices and a small negative impact on the real output of the U.S. agricultural sector. Consequently, economic policies, such as monetization of the federal government debt, will increase overall prices to the agricultural sector.

[22]The statistical results of the estimation of Equations 14 and 15 were very similar to those reported above. Consequently, their detailed discussion would be somewhat repetitive.

Table 4. Autoregressive Estimates of Equations 12 and 13

Equation 12				Equation 13			
Statistics		Lags	Coefficients (*t* statistics)	Statistics		Lags	Coefficients (*t* statistics)
R^2	0.78499	ln RGFP (-1)	0.484	R^2	0.99912	ln FHCPI (-1)	1.178
			(4.699)				(11.378)
S.E. of		(-2)	0.028	S.E. of		(-2)	-0.031
regression	0.0476		(0.245)	regression	0.013		(-0.206)
		(-3)	-0.006			(-3)	-0.186
DW	1.983		(-0.063)	DW	1.862		(-1.219)
		ln FHCPI (-1)	0.120			(-4)	0.269
F	67.909		(1.539)	F	8701		(1.770)
		ln B (-1)	-0.015			(-5)	-0.570
			(-0.237)				(-3.812)
						(-6)	0.277
							(2.793)
						ln RGFP (-1)	0.021
							(0.715)
						(-2)	0.041
							(1.270)
						(-3)	-0.109
							(-3.170)
						(-4)	0.047
							(1.492)
						ln B (-1)	0.059
							(3.048)

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Evidence of the Stability of Income Tax Expenditures to Farmers

Gregory D. Hanson and Vernon R. Eidman

Abstract

Estimates of tax expenditures (savings on tax liabilities due to use of tax preferences, credits, and deductions) were estimated for a sample of southern Minnesota farms. Tax savings remained at approximately the same real levels in 1979–82 as in the growth period of the early and mid-1970s. Tax expenditures averaged $5,971 (1972 dollars) for the sample and ranged from $2,551 on small farms to $9,500 on large farms. A larger proportion of the tax savings resulted from interest-related deductions in 1979–82 relative to investment-related depreciation and investment credits. Incomes declined in real terms and effective tax rates increased in the later period. The level of unused credits and deductions nearly doubled, reflecting economic difficulties in the early 1980s.

Key words: policy, subsidies, taxes, tax expenditures.

Income tax preferences affecting agriculture have recently been termed "the silent farm bill" (Senator Daschle, *The Washington Post*, October 14, 1985), and agriculture has been likened to "a tax scam industry" (Thurow).

This paper explores the importance of tax expenditures (or tax preferences) during a recent period of low economic growth in agriculture.[1] The objectives are to update data on tax expenditure behavior into the early 1980s, including levels of tax expenditures, effective tax rates, and tax losses and to examine the effects of a period of economic downturn on the size of tax expenditures. The empirical results are based on two related time series that are cross sections of farm management association records from southern Minnesota. The smaller sample traces changes in tax expenditures, taxes paid, and effective tax rates over a sixteen-year period. The larger sample is representative of commercial farming operations in the area in recent years.

Recent Research

Tax issues have become of paramount interest in recent years because of the perceived need to reduce annual federal budget deficits of more than $200 billion. That interest has resulted in Congress debating several tax simplification and

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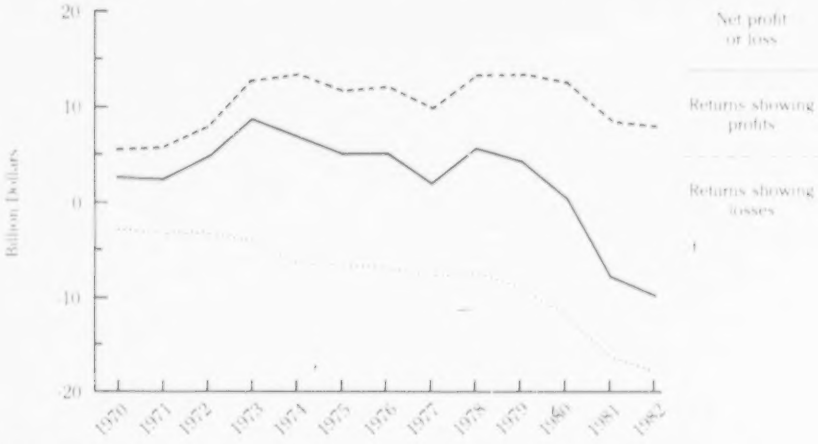
[1]The term "tax expenditure" was popularized by Surrey, and it implies favorable or exceptional tax treatment that reduces tax liabilities (that would have otherwise resulted from the underlying tax rate structure). It constitutes government financial assistance for taxpayers thus favored. The comprehensiveness of the term (i.e., the credits and deductions viewed to be tax expenditures) is subject to varying definitions. In this analysis the terms tax expenditure, tax preference, and tax savings are used interchangeably to refer to the tax provisions in lines 1–5 of Table 2.

Figure 1. Annual Profits and Losses from Farm Sole Proprietorship Tax Returns, 1970–82



Source: Ron Durst, Finance and Tax Branch, Economic Research Service, U.S. Department of Agriculture

reform proposals.[2] Agricultural economists have suggested that the continued difficulties of the agricultural sector are related in part to tax-motivated investment behavior by both farm operators and nonoperating landlords (Davenport, Boehlje, and Martin; Boehlje and Carman). Quantification of tax preferences in agriculture has benefited from several recent studies. Neoclassical investment theory provided a framework for Hrubovcak and LeBlanc who examined aggregate investment effects of tax policy. They estimated that 20 percent of net investment in agricultural machinery since the 1950s was due to tax policy, especially the investment tax credit (ITC).

The increased importance of the Social Security tax on agricultural investment was analyzed by Jeremias and Durst. That study noted that the rapidly escalating rates and the practice of levying the tax on net farm income rather than on wage income have resulted in relatively high Social Security tax rates in agriculture compared with effective federal income tax rates. Mathematical programming and simulation studies of representative farms have generally found that taxes on income generate powerful incentives for farm growth (e.g., Richardson and Nixon; Skees; Hardesty). Batte and Sonka found tax preferences contributed to economies of size among Illinois farmers, particularly in the case of the ITC provision.

General support for tax reform can be found in both farm level and aggregate data. Otto and Hanson found general support among samples of farmers in both Iowa and Alabama. A comprehensive measure of tax record keeping and preparation costs for those sample farms was found to equal typically 40 percent or more of estimated tax liabilities, suggesting the current tax system is not characterized by a strong public revenue-to-private cost ratio (Hanson, Kinnucan, and Otto). At the aggregate level, Durst found that sole proprietors in agriculture reported positive farm profits on their federal income tax returns annually during 1970–80 (Figure 1). However, farm losses reported by sole proprietors exceeded farm profits by $7.8 and $9.8 billion in 1981 and 1982, respectively. That occurred in spite of $29.8 and $24.6 billion estimated net farm income in 1981 and 1982 (USDA). Commenting on the tax loss issue, Thurow has suggested tax reform could limit the use of agriculture as a tax shelter industry.

Previous research indicated that annual average tax expenditures per farm increased more than threefold in real terms (1972 dollars) from 1967–72 to 1973–78 (Hanson and Eidman). Regression analysis suggested that tax expenditures were primarily a function of farm size rather than enterprise type. Furthermore, it was found that farmers'

[2]Those include the Bradley-Gephardt "Fair Tax Act of 1982," Crane's "Flat Tax Act of 1982," and other flat rate or modified flat rate proposals offered by Kemp-Kasten and the U.S. Treasury Department.

abilities to utilize tax credits and deductions in the year they became available declined dramatically from the 1967–70 to the 1975–78 period. Approximately one-third of the sample farms were unable to utilize large amounts of the available credits and deductions during the latter period. The study period ended with 1978, and it was unclear that the trend to higher levels of tax preferences and increased difficulty in using tax credits as they became available would be sustained in less prosperous times. That issue is particularly relevant because tax losses burgeoned in 1980–82—averaging $15.3 billion—and because 1980 was apparently the first year since 1966 that the number of farm sole proprietorships reporting tax losses exceeded the number reporting profits (Reinsel and Browning; Durst).

Data and Model

The original study was based on records for 1967–78 from a panel of seventy-six farmers. (Hanson and Eidman). Of the seventy-six farmers, fifty-two continued to maintain records with the Minnesota Farm Management Associations each year during the 1979–82 period. The sample of fifty-two farms provided the base sample for this study. Data were also analyzed from the larger sample of all farmers that participated continuously in the associations over the 1977–82 period.

The farmers in the base sample had a minimum of sixteen years in farming at the end of 1982. Those operators had the opportunity to purchase at least some of their assets during periods of lower nominal prices and to operate those businesses during the early and mid-1970s, a period of relative prosperity. As a result the farmers in the sample were expected to be in a stronger relative financial position than farmers in the larger sample of 163 farms that participated continously in the associations over the shorter 1977–82 period.

The larger sample was considered to be more representative of commercial farms in the area, and it provided a comparison for the 1979–82 extension of the smaller sample. The farms in both samples were categorized as small, medium, and large size based on average sales of less than $100,000, $100,000–$199,999, and $200,000 or more, respectively (1972 dollars). The farms were classified by average sales over the entire 1967–82 period, a method that may permit some distortion to occur if significant growth or contraction occurred during the study period. That classification method has the advantage, however, of ensuring that net operating loss, ITC, and inventory behavior changes of a given farm affect the same size class over time. The primary enterprises on the sample farms were corn, soybeans, hogs, and cattle feeding. Cattle feeding was most prominent on the large farms.

Some size and financial characteristics of the base sample of fifty-two farms and the way they changed over the 1967–82 period are indicated in Table 1 and Figure 2.[3] While farm sales increased substantially from $76,500 to $114,642 between 1973–78 and 1979–82, there is evidence of worsening financial conditions in the remaining categories of Figure 3. The average market value of farm assets peaked in the 1973–78 period, then declined slightly to $361,347. Average debt increased by nearly one-third from the 1967–72 period, reaching $89,369 in the 1979–82 period. Average real interest expenses nearly doubled from the first six years to the last six years, reaching $8,808 in the 1979–82 period. Average annual machinery purchases peaked in the 1973–78 period, then declined 17 percent to $14,137, indicating economic contraction.[4]

The model employed in this study is a comprehensive tax accounting model that includes annual changes in tax rates and tax savings provisions during the period studied. The model includes federal income averaging, federal and state net operating loss carry-overs, federal investment credit (ITC) carry-overs, as well as treatment of capital gains, earned income, minimum tax, and social security tax.

The tax expenditures model consists of five

[3]Comparison with the large 163 farm sample is provided in the first section of Table 5.

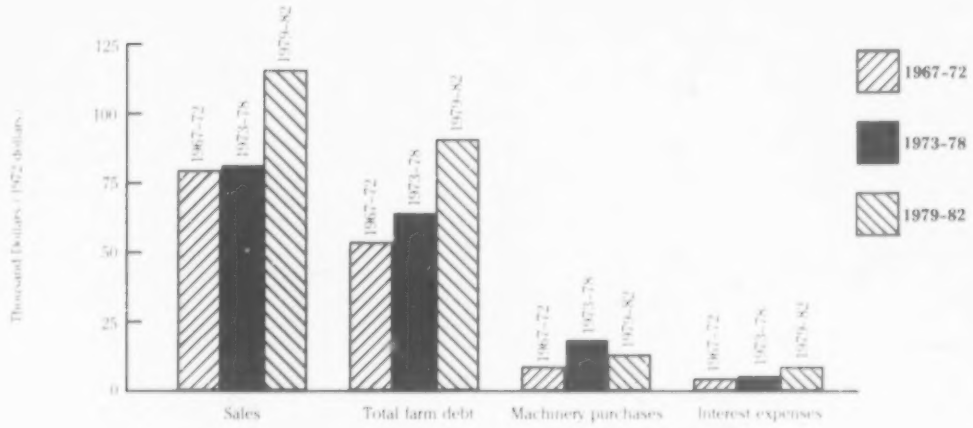
[4]The decline in assets and investment would almost certainly have been accentuated by the post-1982 erosion of the land market and the continued financial stress of the agricultural sector ("The Current Financial Condition of Farmers and Farm Lenders," "Financial Characteristics of U.S. Farms, January 1985").

Table 1. Average Annual Sales and Size Characteristics

	All Farms			Small Farms			Medium Farms			Large Farms		
	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72
Owned acres	263[a]	289[b]	211[ab]	152*	201*	159*	221*	234[b]	194[b]	392*	413[ab]	268[ab]
Rented acres	159	126	137	100*	88*	89*	128[b]	104[b]	110[b]	237[ab]	179[ab]	202[ab]
Total farm assets ($1972) ($000)	361*	365[b]	178[ab]	159*	213*	109*	287*	301*	161*	598*	551*	251*
Gross Sales ($1972) ($000)	115*	102[b]	77[ab]	37*	39*	30*	71*	78*	59*	219*	176*	131*
Total farm debt ($1972) ($000)	89[ab]	61*	54[b]	39*	26*	21*	79*	48*	38*	141*	101*	96*

Source: "Base" continuous sample of fifty-two farms, 1967–82, with 16*, 17*, and 19[b] farms in the small, medium, and large sizes, respectively. Tests for statistical significance are based on Cochran's approximation for analysis of independent samples (alpha = .05); see Snedecor and Cochrane, p. 114–116. Significance tests for the all farm categories are between periods. Tests among alternative farm sizes are within the same period, across alternative sizes. Means marked with an asterisk are significantly different from all other means in the comparison. Means with *a* or *b* are significantly different from other means bearing the same letter. For example, owned acres was significantly different between 1973–78 and 1967–72 for all farms, while the mean for all farms between 1973–78 and 1979–82 did not differ significantly; owned acres was significantly different for 1979–82 among small, medium, and large farms.

Figure 2. Size Characteristics of Farms, 1967–82

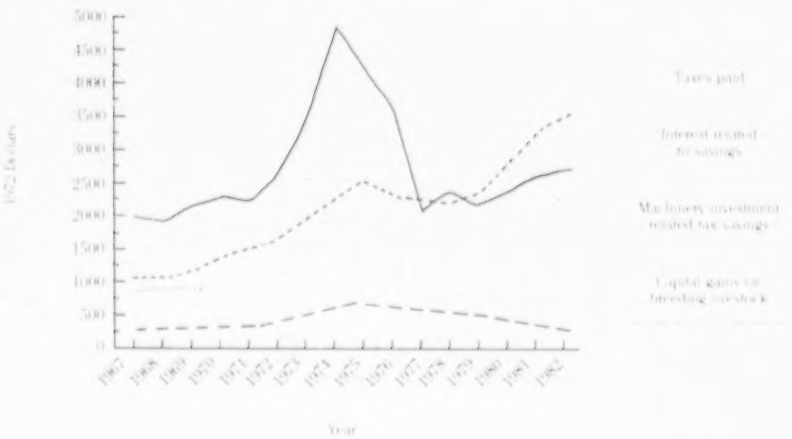


fundamental steps: computation of adjusted gross income and a second income measure that abstracts from tax definitions; determination whether itemization or the standard personal deduction is preferrable to reduce adjusted gross income; computation of base federal, state, and self-employment taxes on income, based on tax rates and provisions in effect for each year of the time period; computation of the effect of five preference provisions (investment credit, accelerated depreciation, capital gains on livestock, cash basis tax accounting; and interest expense deduction) on base federal, state, and self-employment tax levels; and estimation of annual tax liabilities and preferences for individual farmers at each tax level.

The record data includes value of inventories, off-farm income, number of dependents, and tax paid information used to validate the model (Hanson, pp. 93–109). Because the tax paid information was not provided by all sample farmers, the model estimated both the tax paid and the distribution of tax paid among federal, state, and social security taxes. In addition, the model also generated an estimate of tax savings and the amount of unused or lost deductions and credits for each farmer in the sample at each level of taxation. A flow chart of the model is provided elsewhere (Hanson, p. 62).

Accelerated depreciation was estimated to be the depreciation claimed in excess of economic depreciation. Economic depreciation for machinery and buildings was based on twelve- and thirty-year economic lives, respectively, and declining balance depreciation rates of 1.25 and 1.1. By comparison, the USDA assumes service lives for tractors, other machinery, and buildings of twenty-three, twenty, and forty years, respectively. USDA also uses slightly higher declining balance depreciation rates (Gustafson, et al.). Cash accounting tax preference arose when the expense of producing crops was recognized in a tax year prior to the tax year in which sale of the production was completed. Production Credit Association interest rates (7.71 to 10.28 percent) for the study area were used to compute the value of the subsidy. Additional information on the valuation procedures used to calculate tax expenditures for the five preference procedures is provided in Hanson and Eidman, pp. 272–273.

Figure 3. Taxes Paid and Tax Savings by Provision, 1967–82 (3-year moving average, 1972 dollars)



Study Results

Empirical information on tax behavior is frequently difficult to obtain because of the complexity of the tax codes and farmers' desire for confidentiality. Sufficiently detailed data were available on the sample farms to make empirical estimates of income, tax savings, tax rates, and unused tax credits and deductions.

Tax Savings

The tax savings for the base sample appear to have leveled off during 1979–82 (Table 2). After an increase from $2,877 to $5,774 between 1967–72 and 1973–78, the increase to $5,971 in the final period was not statistically significant. Considering the change by farm size, neither the small decline in tax savings between 1973–78 and 1979–82, nor the increase for medium and large farms over the same period was significant.[5]

The trends in tax savings tended to be consistent across farm sizes, with some notable exceptions. Capital gains and investment credit declined for each size, and accelerated depreciation declined for small and large sizes but was level for medium size farms. State tax savings increased for medium and large size farms, but social security tax savings increased dramatically for all three size groups. Those data indicate the increasing importance of tax savings provisions to state and social security taxes. For example, the average social security tax rate and maximum income covered increased from 7.95 percent and $14,600 in 1973–78 to 8.73 percent and $27,725 in 1979–82.[6]

The substantial decline in investment-related tax savings that began in 1979 (Figure 3) is a prominent result of the changing economic environment during the late 1970s and early 1980s. Those savings consist of the ITC and accelerated depreciation related to machinery and building assets.[7] Taxes paid increased only moderately after 1979 in spite of the decline in investment-related activity

[5]The statistical significance tests were conducted across time periods for the all-farm category. The remaining tests were conducted across farm sizes within periods, however, to analyze the significant differences by size of farm.

[6]The interplay of both tax rates and deduction provisions applicable to state income taxes determines the importance of state taxes to farmers. Minnesota maximum individual income tax rates have been among the highest in the U.S. and these results may not be typical for many states with lower maximum tax rates.

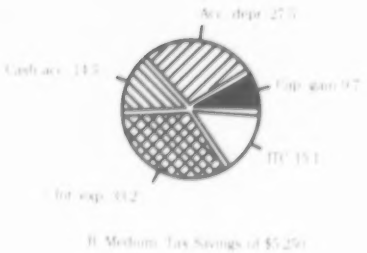
[7]A small amount of investment credit and accelerated depreciation occurring on purchased breeding livestock may be included in the measure. Sample average breeding livestock purchases declined from $337 during 1973–78 to $120 during 1979–82.

Table 2. Annual Average Agricultural Tax Expenditures by Tax Provisions and Farm Size (1972 dollars)

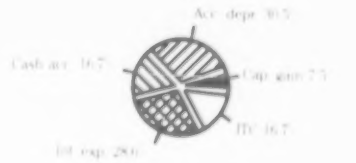
	All Farms			Small Farms			Medium Farms			Large Farms		
	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72
1. *Capital gains on livestock*	327[a]	603[a]	359	192[a]	201[ab]	170[ab]	509[ab]	759[a]	448[a]	277[b]	801[b]	440[b]
2. *Accelerated depreciation*	1,435*	1,590[b]*	719[ab]*	778*	886*	422*	1,444*	1,442*	611*	1,983*	2,315*	1,066*
3. *Cash basis tax accounting*	1,323*	871*	406*	425*	402*	142[a]	761*	722*	479*	2,581*	1,401*	564*
4. *Interest expense deduction*	1,939*	1,478*	1,069*	730*	729*	463*	1,744*	978[b]*	620*	3,131*	2,556[ab]*	1,982*
5. *Investment credit*	947[a]	1,231[b]	323[ab]	426*	572*	211[a]	791*	1,154*	272[b]	1,527*	1,855*	462[ab]
6. *Total tax savings*	5,971*	5,774[b]*	2,877[ab]*	2,551*	2,790*	1,409*	5,250*	5,057*	2,430*	9,500*	8,928*	4,514*
7. *Shares of tax savings*												
a. Federal income tax	4,146	4,479	2,124	1,285	1,994	977	3,863	4,001	1,751	6,732	7,001	3,425
b. State income tax	1,273	1,068	616	485	598	279	925	871	540	2,145	1,638	967
c. Social security tax	552	227	137	355	198	152	461	184	140	623	289	122

Source: "Base" continuous sample of fifty-two farms, 1967–82.
*, a, b. See footnote to Table 1. Item 7 was not tested for significance as variances were not computed.

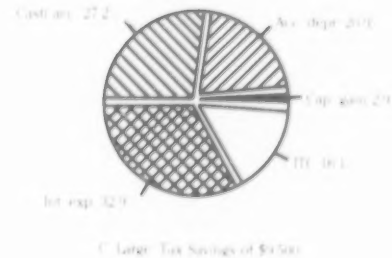
Figure 4. Average Annual Tax Savings by Provision and Farm Size, 1979–82 (1972 dollars)



B. Medium Tax Savings of $5,250



A. Small Tax Savings of $2,551



C. Large Tax Savings of $13,500

and the substantial increase in nonfarm income, from an annual average of $1,626 in 1972–78 to $4,162 in 1979–80. The major reasons for the moderate growth in taxes paid were the rapid growth of the interest-related tax savings due to the interest deduction and the tax-delaying value of cash accounting. Given the decline in farm income and farm investments, the authors suggested that tax savings would decline during the early 1980s (Hanson and Eidman, p. 277). Instead they remained at approximately the same level during the 1979–82 period. To the extent that high nominal interest rates are associated with a period of farm income stress, the situation suggests (with current income tax structure and preference provisions) that tax expenditures may be "downwardly sticky" during periods of agricultural recession.

The size of tax expenditures during the 1979–82 period is illustrated for small, medium, and large size farms in Figure 4. The area of the three pies have been adjusted to represent relative expenditure levels. Interest and accelerated depreciation account for 54 to 61 percent of tax savings. Cash accounting is relatively more important on large farms (27.2 percent of average annual tax savings) that have large sales of cash crops and livestock from feeding enterprises. Capital gains are relatively more important on the small (7.5 percent) and medium farms (9.7 percent) because they have more breeding livestock. The ITC, however, accounts for 14 to 16 percent of the tax savings on all farm sizes during the most recent period.

The impact of the tax expenditures upon tax liabilities and rates is depicted in Table 3. Average annual tax liabilities in 1967–72 were 95 percent of the 1979–82 level ($2,625) for the all-farm category. Taxes in 1973–78 were 132 percent of the 1979–82 level. The percentage reduction in taxes paid was greatest on small farms and least on large farms.[8] Social security taxes increased

[8]Several cattle feeders in the large farm size suffered major losses during the period. Large losses for a few specialized firms may lower taxes less (for the group as a whole) than an equivalent amount of losses spread over a wider number of producers. Between 1973–78 and 1979–82, expanded income (which reflects operating losses) was reduced relatively more than tax liabilities for the large compared with medium and, in particular, small size farmers.

Table 3. Annual Average Taxes, Expanded Income, and Effective Tax Rates by Time Period and Farm Size (1972 dollars)

	All Farms			Small Farms			Medium Farms			Large Farms		
		Previous periods compared with 1979–82			Previous periods compared with 1979–82			Previous periods compared with 1979–82			Previous periods compared with 1979–82	
	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72
1. *Annual total tax*	$ 2,625	132%[a]	95%[a]	$1,451[ab]	161%[a]	94%[ab]	$ 3,262[a]	132%[a]	78%[a]	$ 3,045[b]	122%	112%[b]
a. Federal income tax	1,030	131	125	468[a]	186[a]	124[ab]	1,466[a]	125[a]	88[a]	1,115	119	168[b]
b. State income tax	959[a]	156[ab]	79[b]	459[ab]	188[ab]	81[a]	1,071[a]	165[a]	72[a]	1,281[b]	140[b]	84[a]
c. Self-employment tax	635[a]	99[b]	70[ab]	524[a]	114[a]	77[a]	725[a]	96[ab]	67[a]	648	92[b]	68
2. *Expanded income*[1]	$13,674[a]	161%[ab]	114%[b]	$8,596[a]	167%[ab]	121%[ab]	$16,067[a]	150%[a]	105%[a]	$15,808	169%[b]	120%[b]
3. *Total effective tax rate on expanded income*	$19.2	82%	83%	$16.9	96%	78%	$20.3	88%	74%	$19.3	72%	93%
a. Federal	7.5	81	109	5.4	113	104	9.1	84	84	7.1	69	139
b. State	7.0	97	70	5.3	113	68	6.7	109	69	8.1	83	70
c. Self-employment	4.6	63	61	6.1	69	93	4.5	64	64	4.1	54	56
4. *Total effective tax rate on adjusted gross income*	$34.6	63%	59%	$24.4	86%	68%	$32.4	72%	59%	$45.3	46%	52%
5. *Effective tax rates per dollar sales*	2.3%	3.4%	3.3%	3.9%	6.0%	4.5%	4.6%	5.5%	4.3%	1.4%	2.1%	2.6%
6. *Effective tax rates per dollar assets*	.7%	1.0%	1.4%	.9%	1.1%	1.2%	1.1%	1.4%	1.6%	.5%	.7%	1.4%

Source: "Base" continuous sample of fifty-two farms, 1967–82.

[1]Expanded income is adjusted gross income plus excess depreciation and capital gains deductions on sale of breeding livestock.

[a,b]See footnote to Table 1. Items 3–6 were not tested for significance as variances were not computed.

from the 1973–79 to the 1979–82 period on all but the small farms, but that increase was more than offset by the reduction in federal and state income taxes on all farm sizes, resulting in smaller total tax in the most recent period.

The sum of state and social security taxes exceeded the federal income tax level for all farm sizes in 1979–82.[9] The burden of the social security tax exceeded that of the federal income tax for small farms, but the state income tax exceeded the federal income tax for the large farms.

Expanded income is adjusted gross income (as defined in IRS form 1040) plus excess depreciation and capital gains deductions on the sale of breeding livestock. That is considered to be a better measure of economic income than adjusted gross income. The relative decline in expanded income from 1973–78 to 1979–82 was larger than the decline in taxes paid. That change resulted from the relative decline in capital gains and in accelerated depreciation tax expenditures that increases the expanded income measure; the relative decline of the ITC that lowers taxes but not expanded income; the real increase in certain types of income, such as wages that are typically subject to higher rates of taxation than income from farm sales; substantial net operating loan losses during 1979–82 for large farms that tend to reduce income levels relatively more than taxes; and a substantial increase in effective social security tax rates. The result is an end period effective tax rate on expanded income that exceeds both the beginning and the middle period rate for all farm sizes. The effective rate in 1979–82 was greater for medium (20.3 percent) than for either small (16.9 percent) or large farms (19.3 percent).

The combined tax rate on adjusted gross income, (item 4, Table 3), 34.6 percent, was approximately 40 percent higher than in earlier periods. Increases in Minnesota state tax and social security tax rates were primarily responsible for the increase. The near doubling of the maximum covered income between 1978–82 was more acutely felt on the large farms. The self-employment tax was consistently regressive with small farms paying the highest effective rates during all three time periods. Medium size farms were estimated to have paid the highest federal income tax and total effective tax rates during 1973–78 and 1979–82. Although there did appear to be a decrease in progressivity for the federal income tax after the first period, Minnesota income taxes appeared to have become more progressive during 1979–82. Those trends tend to be confirmed in the validation sample below.

Finally, data in Table 3 indicate that tax rates per dollar of sales and per dollar of assets declined from 1973–78 to the later period. That is not surprising given the decline in net income during the 1979–82 period and the limited adjustment that had taken place in asset values by the end of 1982.

Tax Losses

Aggressive tax management preceeding and during periods of declining incomes may result in what has been referred to as "over doing tax management." The generation of excess, or unused, tax credits and deductions has been suggested as an alternative form of tax loss (Hanson, Eidman, and Welsch). The results shown in Table 4 suggest that farm operators in the sample had more difficulty using the available tax credits and deductions during the more stressful 1979–82 period. Significant increases in unused tax credits and deductions occurred on all farm sizes, while nearly doubling in real terms for the sample as a whole.

The average annual amount of unused credits and deductions was significant for all farm sizes during the recent period. Although small and medium size farms could have reported more than $3,500 in annual added income without paying additional taxes, large farms could have shielded about $8,000 of added income. Personal deductions and exemptions that were lost plus net operating losses were responsible for most of the unused income shielding value, with ITC making up the remainder. There has been a general increase in the unused part of each of those three types of credits and

[9]The highly progressive Minnesota state income tax, with maximum marginal rates of 16 to 17 percent during 1979–82, and the rapid increase in social security tax rates and maximum covered income levels are responsible for that result. Whether the finding would hold for many other agricultural states is an empirical issue that merits examination.

Table 4. Annual Average Federal Tax Credits and Deductions Remaining or Lost by Period and Farm Size (1972 dollars)

	All Farms			Small Farms			Medium Farms			Large Farms		
		Previous periods compared to 1979–82			Previous periods compared to 1979–82			Previous periods compared to 1979–82			Previous periods compared to 1979–82	
	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72	1979–82	1973–78	1967–72
1. *Unused Credits*												
a. Investment credit remaining	$ 472[a]	69%[b]	10%[ab]	$ 350	46%[a]	7%	$ 570	44%	9%	$ 486	109%[a]	1%
b. General tax credit[1] lost	NA	—	NA	NA	—	NA	NA	—	NA	NA	—	NA
Total	472	77	10	350	53	7	570	49	9	486	121	13
2. *Unused Deductions*												
a. Personal deductions and exemptions lost	1,393[ab]	58[a]	55[b]	927[a]	48[a]	54[a]	1,115[b]	44[b]	36[b]	2,035[ab]	70[ab]	6
b. Net operating loss remaining	2,474[ab]	7[a]	8[b]	1,192[a]	11[a]	7[a]	953[b]	52	6[b]	4,915[ab]	7[a]	8[ab]
c. Total unused deductions	3,867	26	25	2,119	27	28	2,068	26	22	6,950	25	24
3. *Income Shielding Value* of unused credits and deductions[2]	5,231	51	23	3,553	41	21	3,827	45	19	8,022	57	24

Source: "Base" continuous sample of fifty-two farms, 1967–82.

[1]The general tax credit was in effect only during 1975–78. Respectively $38, $23, $28, and $58 of that credit was lost by all, small, medium, and large farms during the 1973–78 period.

[2]The income-shielding value of unused credits and deductions for each time period is the sum of unused deductions and unused credits divided by the average tax rate based on adjusted gross income for that time period.

[a,b]See footnote to Table 1. Items 2 and 3 were not tested for significance as variances were not computed.

deductions, but the largest relative change resulted from increased net operating losses on the small and large farms.

Application to the Larger Sample

The tax accounting model was applied to the larger sample of 163 farms available for the last six years of the study period. The purpose was to determine if a similar pattern of tax liabilities, effective tax rates, and tax losses also prevailed in the larger sample. The larger sample is considered by many familiar with the associations to be representative of commercial family farms in the study area. The first two years of the 1977–82 period were used to generate an income and investment base (including generating NOL and ITC carry-overs), and the 1979–82 period was then compared to the same "updated" period for the original panel.

The all-farms category of the expanded sample had more tillable acres, assets, sales, and debt than the farms in the base sample (Table 5, compared with Table 1). The debt-to-asset ratio was .247 for the original sample and .31 for the expanded sample. Size differences among the expanded sample were significant across all farm sizes (Table 5, section I). Correspondent with the more aggressive use of debt and larger operations of the expanded sample compared with the "base" sample, total tax savings of $8,004 exceeded the annual level of $5,971 in Table 2. Tax savings for farms in the expanded sample exceeded those in the base sample for each size category.

Within the larger sample, cash basis accounting, interest deduction, investment credits, and total tax savings differed significantly across all farm sizes. (Tests for statistical significance were not conducted between the base and validation samples for small–large sizes.) Interest expense deductions represented the largest source of additional tax savings for the farms in the expanded sample. For example, interest expenses provided $1,081, or 53 percent of the $2,033 increase in tax savings for the all-farms category. Investment credit and accelerated depreciation, accounting for 15 and 13 percent of the additional tax savings for the all-farms category, were next in order of importance.

Comparing the results in Tables 3 and 5 indicates the tax liabilities for the average of all farms of the expanded sample are $136 greater than for the base sample. The expanded income is modestly greater for small and medium farms in the expanded sample, and the expanded income of larger farms is 53 percent greater. Tax rates on both expanded and adjusted gross income were 20 and 24 percent lower, respectively, for the all-farms category of the expanded sample. The lower tax rates on adjusted gross income and the lack of overall progressivity are more consistent with a younger and a more diverse sample of farm operators.

The problem of unused credits and deductions is more acute in all size categories of the expanded sample. For all farms, the amount of additional income that could have been shielded increased from $5,231 to $9,686 (Table 4 vs. Table 5, section IV). That result would also be anticipated in a sample of younger, larger, and more heavily indebted farmers during a period of downturn in farm income.

Summary

Earlier research with a sample of farm management association members had suggested that tax expenditures were large and pervasive among all farm sizes and had experienced remarkable growth during the early and mid-1970s. The updating of that research confirms that tax expenditures continued to be of comparable importance (in real terms) to the sample during the more financially depressed period 1979–82. While expanded income, adjusted gross income, and tax liabilities declined in real terms, tax expenditures were stable (contrary to prior expectations), and unused tax credits and deductions increased significantly. Reservations concerning the representativeness of a sample of fifty-two farms with a sixteen-year history led the authors to compare the results with all 163 farms having a six-year history. Tax expenditures for the larger sample of presumably younger, more expansion-oriented farmers and larger farms indicated that tax savings and losses were larger and the effective tax rates lower than in the original sample. The self-employment Social Security tax, as expected, was found to be regressive; the Minnesota state income tax

Table 5. Tax and Size Characteristics of the 1979–82 Validation Sample of 163 Farms (1972 dollars)[1]

	All Farms	Small Farms	Medium Farms	Large Farms
I. *Sales, size characteristics*				
1. Tillable acres: a. Owned	249	156*	234*	332*
b. Rented	238*	153*	175*	386*
2. Total farm assets	379,268	183,612*	329,235*	584,084*
3. Gross sales	126,165	43,446*	88,166*	237,378*
4. Farm debt	117,642*	60,181*	93,163*	192,693*
II. *Tax savings by provision* (comparison with Table 2)				
5. Capital gains on livestock	441*	255*	581**	361*
6. Accelerated depreciation	1,704*	1,011**	1,809*	2,017*
7. Cash basis tax accounting	1,592	517*	1,141*	2,974*
8. Interest expense deduction	3,020*	1,415*	2,628*	4,672*
9. Investment credit	1,246	551*	1,074*	1,966*
10. Tax Savings, total	8,004*	3,749*	7,235*	11,992*
a. Federal	5,685	2,492	5,147	8,621
b. State	1,727	753	1,471	2,758
c. Self-employment	591	504	617	613
III. *Taxes, expanded income and tax rates* (comparison with Table 3)				
11. Tax liabilities, total	2,761	1,226**	2,844*	3,675*
a. Federal tax	1,092	333**	1,159*	1,505*
b. State tax	1,040	428*	1,047*	1,441*
c. Self-employment tax	629	464*	637*	728*
12. Expanded income	17,952*	9,212*	17,709*	24,192*
13. Effective tax rates on expanded income	15.4	13.3	16.1	15.2
a. Federal	6.1	3.6	6.5	6.2
b. State	5.8	4.6	5.9	6.0
c. Self-employment	3.5	5.0	3.6	3.0
14. Effective tax rates on adjusted gross income	26.2	22.0	26.7	26.7
IV. *Federal tax credits remaining or lost* (comparison with Table 4)				
15. Investment credit	620	406	589	808
16. Total deductions	7,320	4,360	4,629	12,965
a. Personal deductions and exemptions	1,476	1,212*	1,403	1,761*
b. Net operating loss	5,754*	3,148*	3,226*	11,204**
17. Income shielding value of unused credits and deductions	9,686	6,205	6,834	15,991
Number annual observations	163	35	76	52

[1]The sample farms include the farms present during 1967–82. Because 1979–82 is a recent, limited time period, a larger number of farms had completed records all four years compared with the sixteen-year sample.

*,**Statistical tests among small-large sizes were conducted within the expanded sample, not between the base and expanded samples. Tests for statistical significance compare the all-farm category with the base sample. Items 10, 13, 14, and 17 were not tested for significance as their variances were not computed.

was found to be progressive, and the federal income tax lacked progressivity among medium and large size farms.

The decline in deflated investment credit and accelerated depreciation preferences during 1979–82 provided evidence of the effects of lower farm incomes on tax expenditure behavior. Expanding debt levels and high nominal interest rates during 1979–82 increased the value of cash basis tax accounting and interest deduction tax preferences. Although the authors anticipated the decline of tax subsidies during 1979–82, the shift from investment to interest (financial leverage) dominance of tax savings provisions contributed to the stabilization of tax preferences in the sample in a recessionary period. Tax reform limiting interest deductibility and/or cash basis tax accounting would in particular appear to impact the large farms.

The findings presented in this study should not be generalized to a more aggregate level. Although the farms sampled are not known to differ substantially in their behavior from other commercial farms of similar size and enterprise types in the region, there is a need to statistically test the extent to which the farms in the management associations are representative of operations in the area.

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